Appendix D

D-3

Acropora Survey

Port Everglades Feasibility Study

Acropora Coral Survey

Final Report

October 2010

Prepared for:

Jacksonville District
US Army Corps of Engineers
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Jacksonville, FL 32207

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1.0 INTRODUCTION

Dial Cordy and Associates Inc. was contracted by the Jacksonville District, Corps of Engineers, under contract W912HN-05-D-0014 Task Order CS10 to survey for acroporid corals in the vicinity of the indirect and direct impact areas for the Port Everglades Feasibility Study. This survey and report was conducted in support of consultation under Section 7 of the Endangered Species Act.

Two scleractinian corals, elkhorn coral *(Acropora palmate)* and staghorn coral (*Acropora cervicornis*), were listed as threatened species under the Endangered Species Act, as amended on 9 May 2006. A critical habitat rule for these two species became effective on 26 December 2008. Four areas within the coastal United States were proposed as critical habitat units, including Florida (3,442 square kilometers), Puerto Rico (3,582 square kilometers), St Thomas/St. John (313 square kilometers), and St. Croix (326 square kilometers, for a total of 7,663 square kilometers). Critical habitat consists of "Primary Constituent Elements", for Acroporid species, this includes "consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover" (Federal Register November 26, 2008), including habitats from mean high water (MHW) to 30m depth.

Port Everglades, Florida is currently planning a deepening and widening of the federal entrance channel, which is one of the 13 federal channels within *Acropora* critical habitat. *Acropora* critical habitat includes the first, second, and third reefs in the vicinity of Port Everglades down to a depth of 30m; although, *Acropora* has not been documented on either the second or third reefs in the Port's vicinity. The Port Everglades' proposed deepening and widening is anticipated to directly impact 15.35 acres and indirectly impact 91.29 acres (150m buffer) of the first, second, and third reefs. *Acropora cervicornis* colonies are known to exist in the vicinity of Port Everglades, 2,780 feet (848m) to the south of the Port entrance channel, on the near shore hardbottom, and 1,400 feet (427m) north on the first reef (this study, NOVA 2008). These locations are outside the indirect impact assessment area for the Port Everglades' expansion project. As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. To date, no *A.cervicornis* have been identified within the direct or indirect impact areas within the proposed Project area (Dial Cordy 2009).

The Port Everglades *Acropora* survey area includes the direct and indirect impact areas out to 150m from the existing channel from the jetty to the third reef (Figure 1).

2.0 METHODS

A two-tiered approach was used to assess presence of *acroporid* corals adjacent to the Port Everglades entrance channel. These methods include a integrated towed video survey, follow-up groundtruthing diver surveys, and diver surveys following the NMFS protocol.

Legend

------ Existing Channel

Alternative Component

OEC - Outer Entrance Channel

IEC - Inner Entrance Channel

150 m Indirect Impact Zone

0 250 500 1,000 1,500 2,000 Meters

Port Everglades *Acropora* Survey Area Map	
Port Everglades *Acropora* Survey	
Scale: 1 inch = 500 meters	Drawn By: MR
Date: June 2010	Approved By:
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 1

2.1 Integrated Towed Video

Federally maintained navigation channels, within the known range of *Acropora* and the proposed critical habitat, are much larger than 0.25 acres. Federal channels facilitate commercial and recreational vessel traffic, including large shipping freighters, container ships, cruise vessels, and recreational boats. Federal channels have national security issues, and some federal channels serve military installations. In general, federal navigation channels are busy with high vessel traffic transporting goods, people, and services to and from ports, regionally, as well as internationally. Due to the high volume of vessel traffic in federally authorized channels, SCUBA diving can be challenging and, at times, dangerous. Entrance channels are often narrow, allowing minimal width for vessels other than the scheduled commercial and military vessels to pass through the channel. As a result, conducting SCUBA surveys within federal channels should be minimized and only done when necessary.

In order to assess *Acropora* presence and proposed critical habitat over large areas, such as federal channels (>0.25 acre), geospatially referenced qualitative video survey methodology was used, with divers providing additional detailed quantitative data, should either *A.palmata* or *A.cervicornis* be video documented.

Qualitative underwater assessments have been used to characterize benthic habitats over large areas (Miller and Muller 1999). Common methods include diver performed manta tow and more recently underwater towed video (Marcos et al. 2007, Dial Cordy 2001). Qualitative video methods currently in use incorporate geospatial referencing capabilities, which can provide real time geospatial data on the video image (Dial Cordy 2001). This technology allows, with precision and accuracy, staff to return to a particular point on the bottom, using DGPS. This technology is useful in surveying large areas of benthic habitat, where diving may be difficult or dangerous, as in the case of most federal navigation channels. Geo-referenced qualitative video surveys may be used as an initial assessment tool to characterize *Acropora* critical habitat in federal navigation channels, high-traffic areas, and large (>0.25 acre) sites, which are not routinely safe or economical for diving assessments.

The video survey was performed utilizing an integrated towed calibrated video system which records high definition digital video, and is linked to geo-referenced navigational software and a precision positioning system (DGPS) with an accuracy of +/- one-meter. Both a vertical and oblique camera were mounted on the tow fish with digital video recorded and viewed from the surface. Such geo-referenced navigational software programs display the geographical coordinates and video camera depth. These data are seen, in real time, aboard the survey vessel's video screen. The video survey was performed over direct and indirect impact areas (150m beyond direct impact) to adequately cover the site.

Calibration video was recorded in areas of known *Acropora* occurrence, south of Port Everglades, adjacent to Hollywood Beach, near JUL6 (Gilliam et al. 2006). *Acropora cervicornis* colonies were positively identified in the calibration video and morphological characteristics were noted for use in video analysis. Colonies 10cm across were visible up to 2m above the bottom. Above 2m colonies between 10 and 20cm in diameter were visible.

2.1.1 Towed Video Specifications and Coverage:

- Towed video transects were spaced 10m apart and towed 2m to 3m above the substrate, yielding a video record for 40% of the survey area. In total, 65 towed video transects were completed (Figure 2).

  - Minimum detectable coral colony size of 20cm.

  - Oblique and vertical digital images were recorded with position overlays and tow fish depths for post-processing.

2.1.1.1 Acropora Identification from Video

Following the survey, video records were post-processed to visually identify any possible *Acropora* colonies, record their location, and estimate the colony area coverage. Video was visually analyzed by two independent qualified marine biologists for signatures of *Acropora* morphological characteristics:

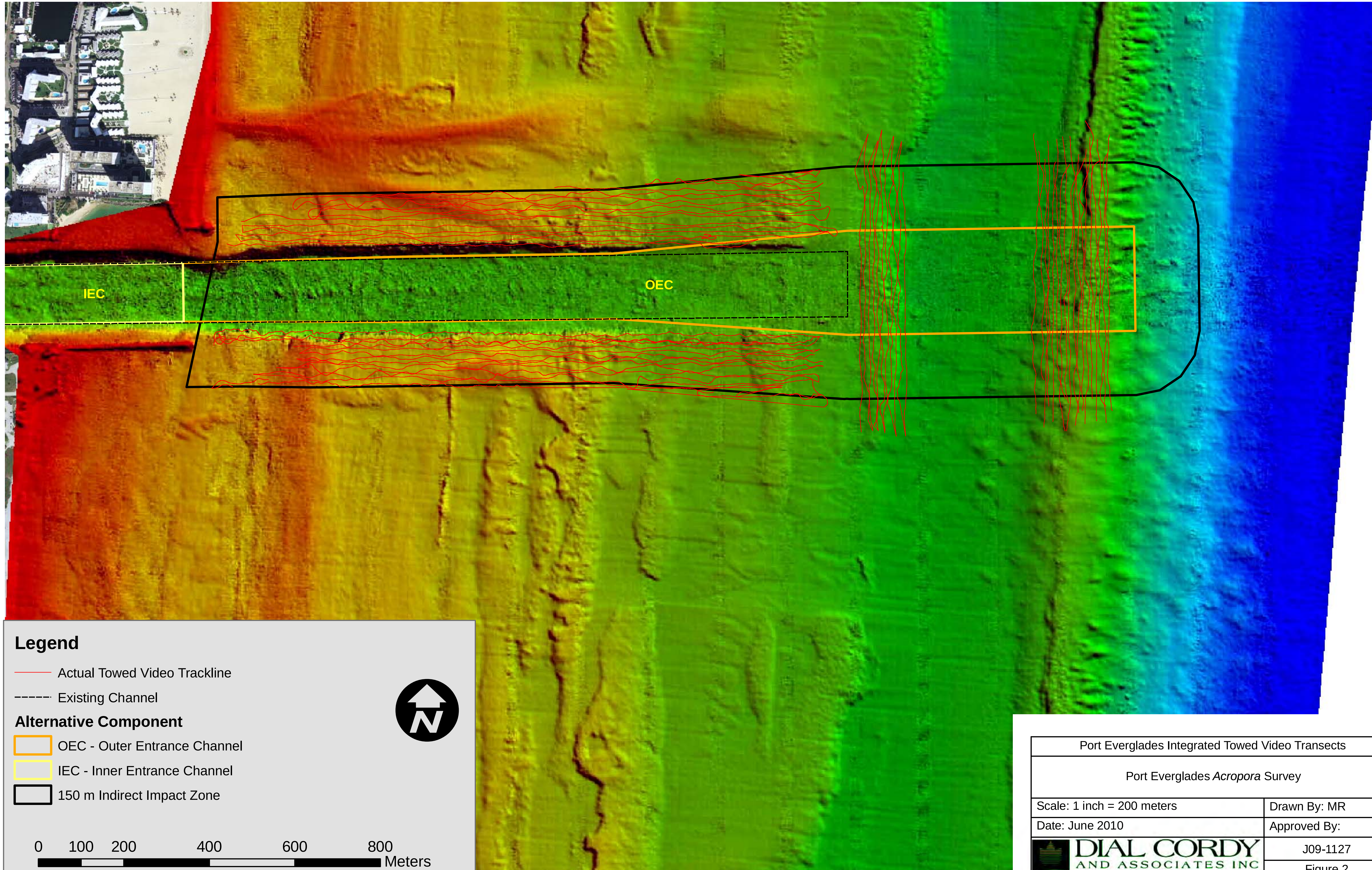
1. Plate (*A.palmata*) or branching morphology (*A.palmata* and *A.cervicornis*)
2. Bouquet appearance – branches radiating from central point (*A.cervicornis*)
3. White tips or edges on colony

Follow-up diver surveys were used to confirm the identity of the organism or organisms identified in the video.

2.1.2 Diver Surveys

2.1.2.1 Video Image Surveys

Post-processed video was groundtruthed by divers at each of 21 locations where potential *Acropora* colonies were identified. A buoy was positioned using the latitude and longitude from the geo-referenced video still-capture. Using the reference still-capture a bounce dive was conducted to verify the identity of the potential acroporid. Once the organism within the reference still-capture was located, a still underwater photograph was taken to document the identity of the potential *Acropora*.



Port Everglades Integrated Towed Video Transects	
Port Everglades *Acropora* Survey	
Scale: 1 inch = 200 meters	Drawn By: MR
Date: June 2010	Approved By:
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 2

2.2 NMFS Diver Protocol Surveys

Diver surveys were conducted for acroporid corals using the "Recommended Survey Protocol for *Acropora* spp. in Support of Section 7 Consultation – Intermediate to Large Project Areas (>0.1 hectare or 0.25 acre)" (NMFS 2007) in nearshore areas and on the third reef (Figure 3).

Intermediate to Large Project Area (> ~0.1 hectare or ~0.25 acre)
Data were collected at one sampling site per 10,000m^2 of critical habitat, such that 16 individual sites within the survey area were surveyed (Figure 3). Survey sites (10,000m^2) were predetermined using ArcView GIS. Reference points were also predetermined using ArcView GIS and set in the center of the 100m x 100m survey site. This design maximized the distance for diver surveys within a site and kept each origin approximately 100m from the nearest adjacent dive site. A reference point was manually relocated based on habitat maps to maximize the likelyhood to surveying *Acropora* habitat (i.e. avoidance of sand). At each sampling site, a single or two-tiered survey was conducted as follows:

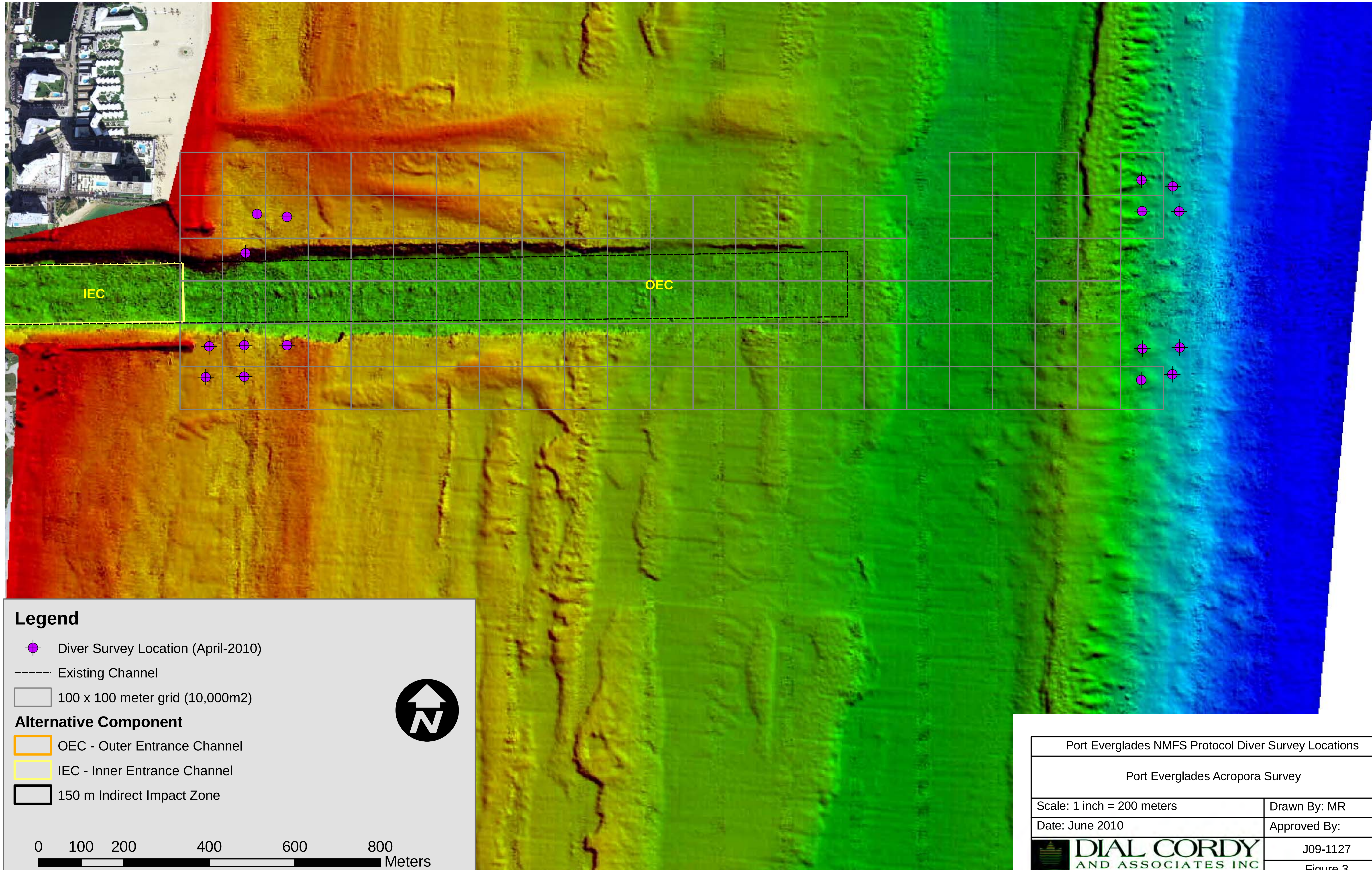
1. First, divers conducted a structured 20-minute timed swim from the referenced center point (i.e., downline). If five or less colonies were encountered, data (see item 2 a-e, below) and photographs were collected on those colonies and divers proceeded to the next sampling site. If more than five colonies were encountered, divers proceeded with additional survey techniques as follows.

2. Divers conducted three belt transects from the referenced center point at three random bearings. Each belt transect measured 4m x 50m, for a total of 200m^2 sampled. All required data were recorded for all colonies encountered along the transects as follows.

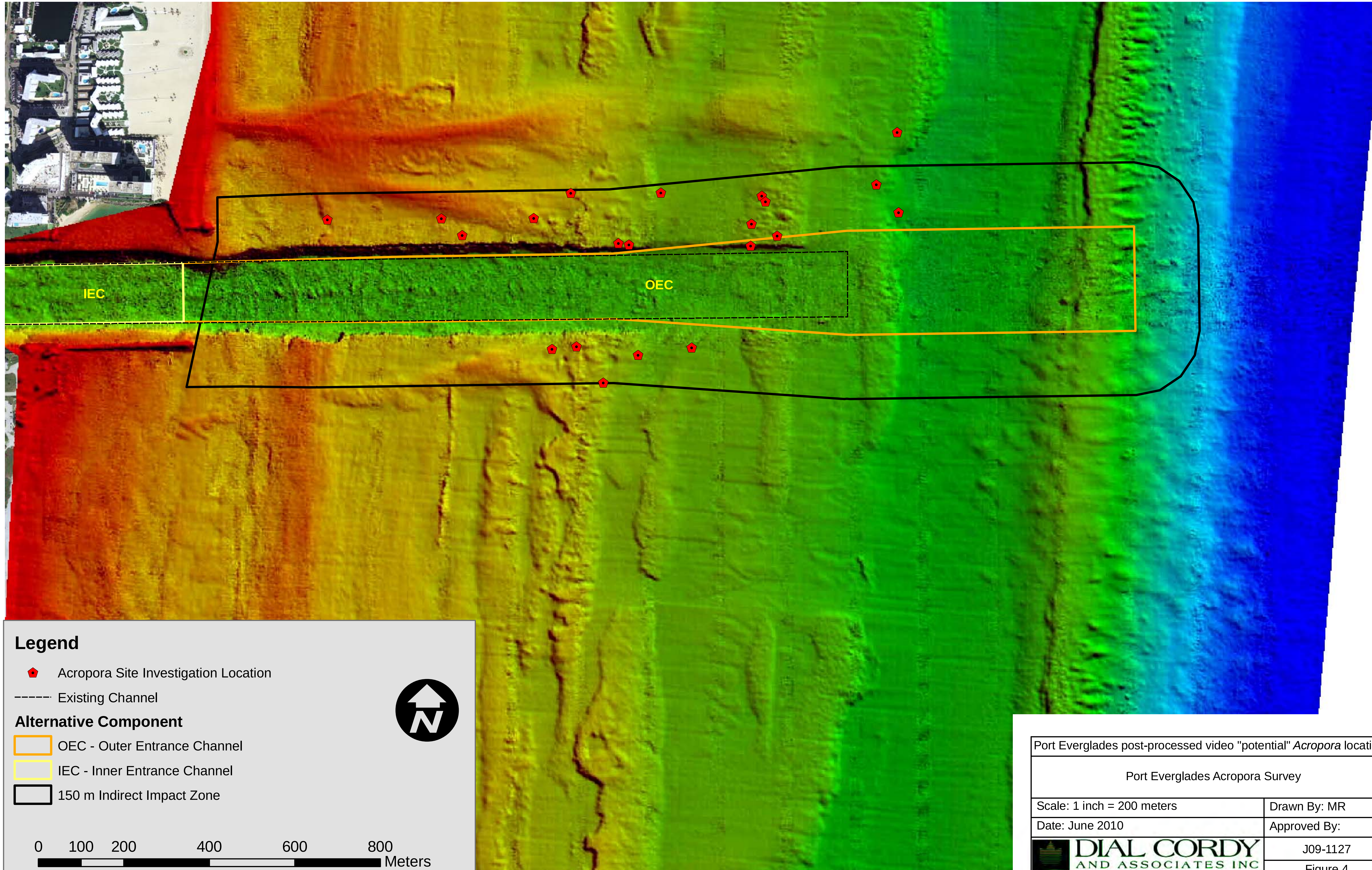
    a. Species;
    b. Single largest linear dimension of the colony or length, height, and width (units = mm) ;
    c. Rank of percentage live tissue (i.e., > or < 50%);
    d. GPS coordinate of each colony (if possible) or each survey site (unit = decimal degrees and state datum); and
    e. Site map with locations of each colony.

3.0 RESULTS

More than 56 acres of *Acropora* critical habitat were surveyed using a combination of towed video and diver surveys within the Port Everglades direct and indirect impact areas (150m north and south of the channel), from the nearshore hardbottom out to the third reef (Figure 2). Video was captured for 40% of the bottom surveyed, along 65 transects. Video was reviewed to document potential *Acropora* colonies for follow-up diver surveys. In total, 21 potential colonies were identified within the survey area (Figure 4). These locations were visited by a diver on November 21, 2009.



Port Everglades NMFS Protocol Diver Survey Locations	
Port Everglades Acropora Survey	
Scale: 1 inch = 200 meters	Drawn By: MR
Date: June 2010	Approved By:
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 3



Port Everglades post-processed video "potential" *Acropora* locations	
Port Everglades Acropora Survey	
Scale: 1 inch = 200 meters	Drawn By: MR
Date: June 2010	Approved By:
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 4

Diver surveys at 21 potential colony locations documented no *A.cervicornis* or *A.palmata* colonies. These results are similar to results from previous mapping efforts within Broward County and in the vicinity of the Port Everglades entrance channel (Thomas et al 2000; Vargus-Angel et al. 2003; Dial Cordy 2009). Organisms identified as potential Acropora colonies were sponges, octocorals, and the hard coral, *Millepora alcicornis* (Table 1).

Additionally, 8 locations were surveyed using the NMFS 2007 *Acropora* protocol (Figure 3). No *Acropora* colonies were identified during these dives on the outer reef or within the nearshore hardbottom. Dives conducted on the outer reef were in 20-35 m, where the habitat consisted of deep water corals, including black corals.

Table 1 Organisms positively identified during diver surveys that were marked as “potential” *Acropora* colonies from post-processed video.

Organisms Identified at Potential Colony Locations	
Sponges	*Iotrochota birotulata*
	Strongylacidon sp.
	Amphimedon compressa
Hard Coral	*Millepora alcicornis*
Octocoral	*Briareum asbestinum*

4.0 DISCUSSION

Underwater video has been used to assess benthic habitats and fish populations in a wide range of habitat types (Somerton and Glendhill 2005). In areas difficult to sample directly, such as Port Everglades, the geo-referenced integrated towed video was an effective tool for rapidly and safely assessing potential *Acropora* habitat.

Towed video, NMFS diver surveys and video confirmation dives were all completed to assess *Acropora* critical habitat within the Port Everglades survey area. Twenty-one dives were made to identify organisms that were designated as “potential” *Acropora* colonies in post-processed video. No *Acropora* colonies were documented within the direct or indirect impact areas of the Port Everglades expansion area during this survey. Currently, it is presumed that the colonies located 2,780 feet (848m) to the south (this survey) and 1,400 feet (427m) north (NOVA 2008) of the entrance channel are the nearest colonies to the project area.

5.0 LITERATURE CITED

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Appendix D

D-4

Seagrass Surveys

Seagrass Mapping and Assessment
Port Everglades Harbor

Final Report

December, 2009

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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was originally subcontracted by Gulf Engineers and Consultants, Inc. (GEC) to conduct an environmental baseline and impact assessment for proposed deepening and widening of Port Everglades, Broward County, FL for the U.S. Army Corps of Engineers, Jacksonville District (Corps), under contract No. DACW17-99-D-0043 in 1999. Data were collected in an initial seagrass survey in 1999 (DC&A 1999). That study included baseline mapping of seagrasses within the project area at Port Everglades and the results are found in DC&A (1999). In 2000 additional survey transects were surveyed and together with 1999 results are presented here and in DC&A (2001).

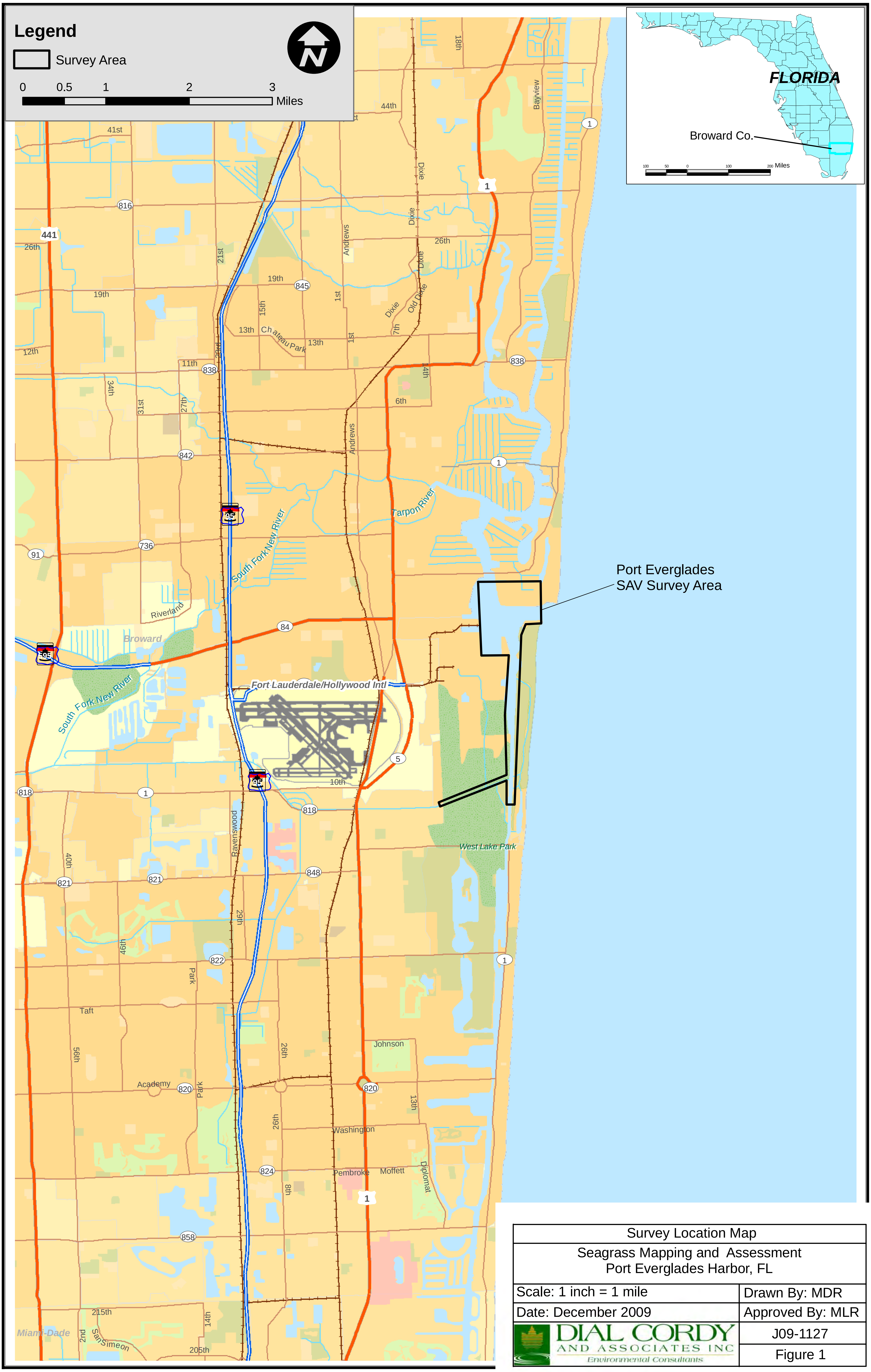
In 2006, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass communities to document any changes that my have occurred in the preceding five to six years. These results are reported in DC&A (2006) and are used for comparison in this report.

In 2009, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass to document any changes that my have occurred to seagrass communities in the preceding three years. The data collected during this study and related composite resource maps are summarized in this report.

Halophila johnsonii was listed as a threatened species by National Marine Fisheries Service (NMFS) on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the AIWW south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within the area considered for widening and deepening.

2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study. Previous resource surveys were conducted in late summer 1999 and 2000, and in May 2001 and June 2006. The most current data was collected in July and August 2009.


Legend
Survey Area
0 0.5 1 2 3
Miles
FLORIDA
Broward Co.
Port Everglades
SAV Survey Area
Fort Lauderdale/Hollywood Intl
West Lake Park
Tarpon River
South Fork New River
Survey Location Map
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1 mile
Drawn By: MDR
Date: December 2009
Approved By: MLR
J09-1127
Figure 1
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants

2.1 Marine Resource Survey

A description of methods utilized to document and characterize marine seagrass communities within the study area (Figure 1) are described below. Surveys were conducted from September 6-10, 1999, September 19-21, 2000, May 16-17, 2001, June 22-25, 2006, July 23-August 3, 2009 (DC&A 1999, 2001, 2006 and this study).

2.2.1 Seagrass Community

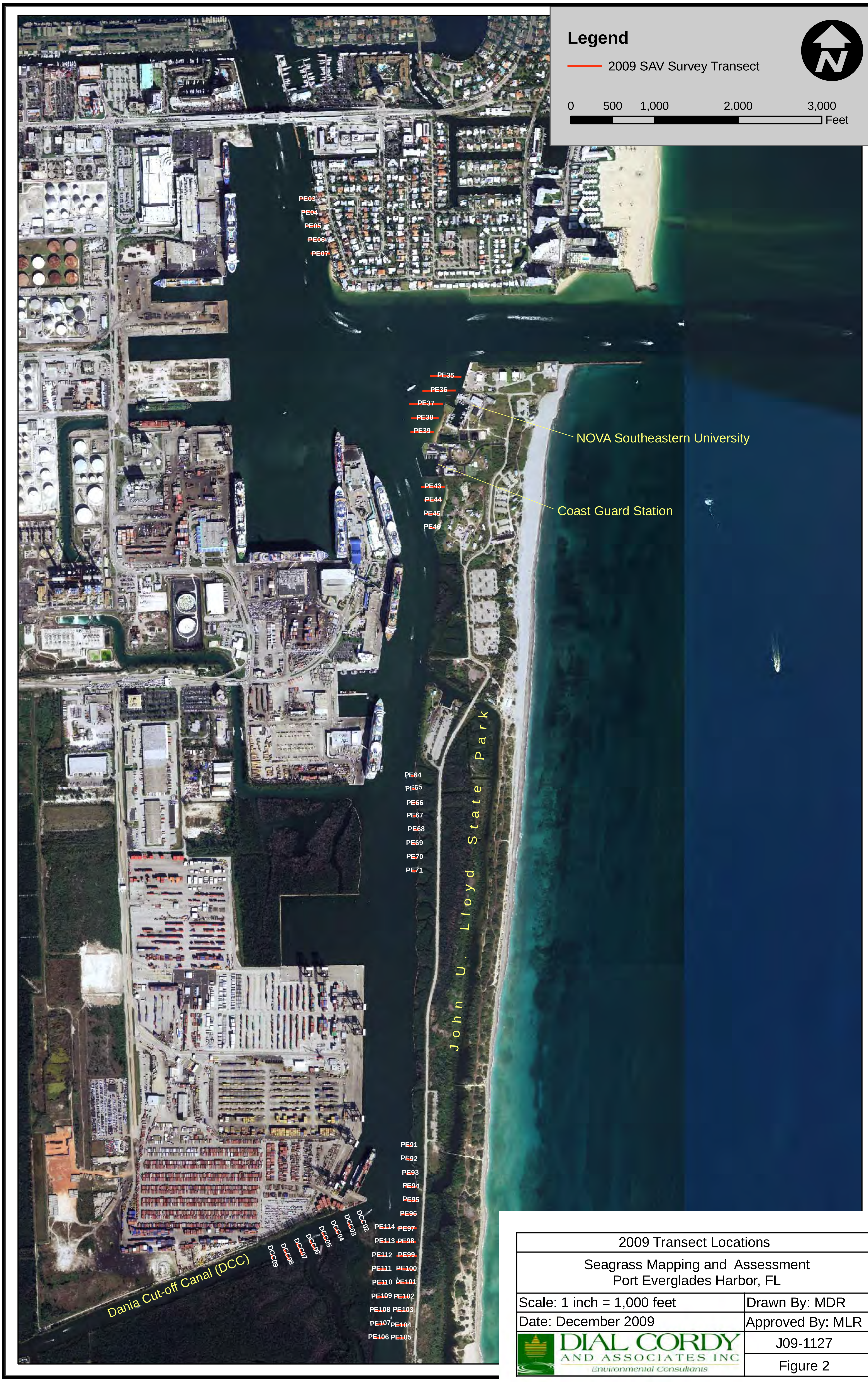
Descriptions of methods used to assess seagrass communities within the Port area are included in this section.

2.2.1.1 Location of Survey Transects

The location of survey transects for the 2009 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC (Figure 2). Transects were located in areas previously surveyed in 1999, 2000 and 2006 so that temporal comparisons could be made.

2.2.1.2 Seagrass Mapping

In 1999-2000 marine seagrass distribution was mapped along 62 transects by locating the end positions using Differential Global Positioning System (DGPS), laying a weighted line marked in one-meter increments from the shore, and then conducting a visual diver survey along the weighted line to document seagrass distribution and occurrence from the shore to the edge of channel. Seagrass habitat and bottom type observed while crossing each transect were noted. Divers drift-dove to the next transect, and if any seagrass was found between transects, a GPS position at the start and end of the grass bed was recorded and the width of the grass bed estimated. Information recorded on seagrass habitat type and distribution was transferred from field logs and entered into a spreadsheet. Descriptions of habitat classifications are shown in Table 1. This approach allowed a visual representation of species' associations and occurrences across the shelf, channel, and slope as compared with bottom depth. Maps were produced for all stations surveyed that had seagrass present. A GIS map (ArcView) and database were created to illustrate seagrass distributions throughout the study area.



Legend
2009 SAV Survey Transect
0 500 1,000 2,000 3,000
Feet
N
PE03
PE04
PE05
PE06
PE07
PE35
PE36
PE37
PE38
PE39
PE43
PE44
PE45
PE46
NOVA Southeastern University
Coast Guard Station
PE64
PE65
PE66
PE67
PE68
PE69
PE70
PE71
John U. Lloyd State Park
PE91
PE92
PE93
PE94
PE95
PE96
PE97
PE98
PE99
PE100
PE101
PE102
PE103
PE104
PE105
PE106
PE107
PE108
PE109
PE110
PE111
PE112
PE113
PE114
DCC02
DCC03
DCC04
DCC05
DCC06
DCC07
DCC08
DCC09
Dania Cut-off Canal (DCC)
2009 Transect Locations
Seagrass Mapping and Assessment
Port Everglades Harbor, FL
Scale: 1 inch = 1,000 feet
Drawn By: MDR
Date: December 2009
Approved By: MLR
J09-1127
Figure 2
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants

Table 1 Habitat Classification System Used for Mapping of Seagrass Species

Habitat Types	Description
Halophila decipiens	Monospecific bed of this species
Halophila johnsonii	Monospecific bed of this species
Halodule wrightii	Monospecific bed of this species
Syringodium filiforme	Monospecific bed of this species
Mixed Submerged Aquatic Vegetation	*S. filiforme or H. wrightii* with *H. decipiens*
Mixed Submerged Aquatic Vegetation with *H. johnsonii*	*S. filiforme* and or *H. wrightii* with *H. johnsonii*
Mixed Submerged Aquatic Vegetation with *H. johnsonii* and *H. decipiens*	*H. wrightii* with both species of *Halophila*
Unvegetated Bottom	Sand, silt or shell substrate with no seagrass or live bottom, may have marine algae present
Live-Bottom Habitat	Sponge and soft coral community over thin veneer of silty-sand

Similar methods were used in the 2006 surveys. Since baseline seagrass maps now existed for the area, a reconnaissance of the area was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with the DGPS and HYPACK software. This allowed the survey team to roughly assess the current distribution of seagrasses in the study area. Then seagrass transects were established in the areas where grass occurred to assess the coverage, abundance, and density. In total 26 seagrass transects were established in 2006. Transect locations were spaced similarly to the previous surveys and care was taken to include transects that would encompass all of the beds encountered.

In 2009 a reconnaissance of the survey areas was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with DGPS and HYPACK software. In addition to the reconnaissance,benthic resource GPS points taken in the summer of 2008 were verified for occurrence of seagrasses (Jocelyn Karaszia personal communication June 18, 2008). This allowed the survey team to roughly assess the current distribution of seagrasses in the study area. Then seagrass transects were established in the areas where seagrass occurred to assess the coverage, abundance, and density according to the Johnson's Seagrass Recovery Survey Protocol for large survey areas (Fonseca et al. 1998). In total 54 seagrass transects, spaced 50m apart in areas of seagrass coverage were surveyed in 2009.

2.2.1.3 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a line point intercept survey was performed along each transect. For each transect in 2009, the average percent (percent of one hundred 10 x 10 cm sub-units within a $1m^2$ quadrat that contains at least one seagrass shoot) was estimated in $1m^2$ quadrats at 5m intervals along the transect line (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). Similar methods were used in 1999, 2000, and 2006, see DC&A (2006). Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful. The cover abundance scale is discussed below.

The cover abundance scale was computed beginning at the zero point and at 5m intervals along each transect. The content of each quadrat was visually assessed and a cover abundance scale value assigned to the seagrass coverage.

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.2.1.4 Analysis and Interpretation of Seagrass Data

Distribution of seagrass community types and their potential occurrence in an area were mapped for each transect from survey data. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

This section includes a description and review of the results of the marine resources survey. It outlines the findings of the seagrass community survey, including species occurrence, abundance, and density for both of the previous surveys and the most current sampling event.

3.1 Seagrass Communities

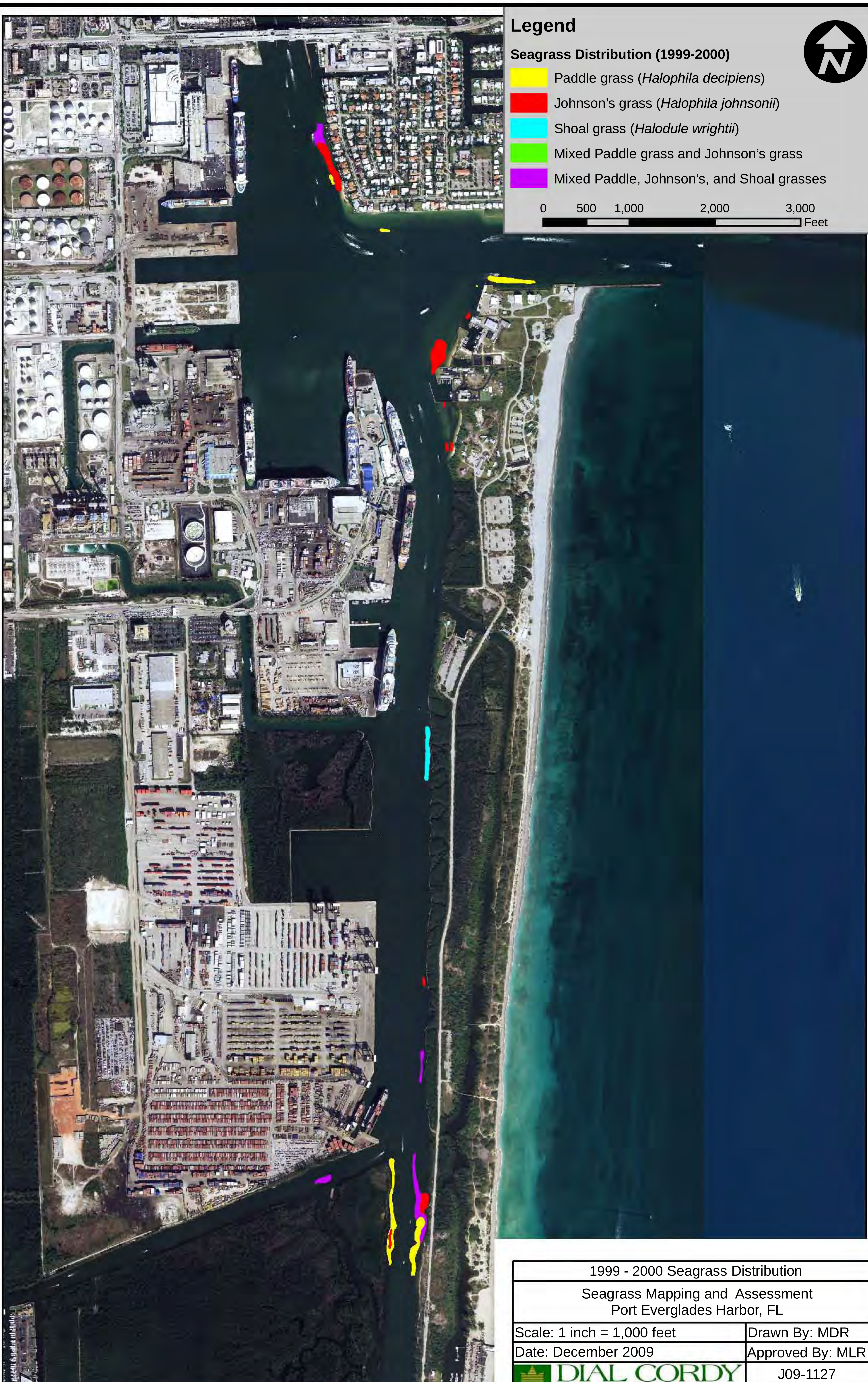
Seagrass habitat cover type, abundance, and density for the study area are described below. Distribution and occurrence observations for the 1999 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (DC&A 1999). Seagrass surveys in 2000 were conducted within the ICWW south of the DCC to the Sheridan Street bridge (DC&A 2001). The combined 1999-2000 data for the survey area (1000 feet south of DCC) were used to create seagrass maps for 1999-2000. To field verify whether seagrass occurred in the Outer Entrance Channel (OEC), as reported by the Broward County Department of Planning and Environmental Protection (DPEP) staff (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County), an integrated video survey was performed in 2001 within the Federal Channel (DC&A 2001).

3.1.1 Seagrass Species Frequency of Occurrence, Abundance, and Density 1999-2000

General Occurrence

Marine seagrass species observed within the study area included *Halodule wrightii, Halophila decipiens,* and *Halophila johnsonii*. Of the 62 transects surveyed in 1999-2000 (Figure 3), marine seagrass species were observed at 19 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 2. DPEP divers documented the occurrence of *H. decipiens* within the OEC (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). Video surveys within the channel confirmed the presence of isolated patchy beds of *H. decipiens* in 45 feet of water, diver transects were not performed within the channel.

Seagrass occurrence within the interior areas consisted of mixed Submerged Aquatic Vegetation (SAV) with *H. decipiens*, *H. wrightii*, and *H. johnsonii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 3).



1999 - 2000 Seagrass Distribution	
Seagrass Mapping and Assessment Port Everglades Harbor, FL	
Scale: 1 inch = 1,000 feet	Drawn By: MDR
Date: December 2009	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 3

Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 11 of the 62 transects sampled. Frequency of occurrence values ranged from 0 to 25% with a mean of 11%.

Other species

H. decipiens occurred within 11 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 67% with a mean of 12%. In comparison, *H. wrightii* had a range of occurrence values between 0 to 24% with a mean of 8% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 4 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 4 of the 62 transects sampled. The abundance values ranged from 0.1 to 1.5 with a mean 0.34. *H. decipiens* however, had values for cover abundance in the 0.1 to 5.0 range with a mean of 0.65.

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with an average value of 0.32 per meter squared. The range of density values for *H. johnsonii* was 0 to 1.0.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.50 with an average of 0.32. *H. wrightii* had the lowest densities of the three species with values ranging from 0 to 0.75 with a mean of 0.15.

3.1.2 Seagrass Species Frequency of Occurrence, Abundance, and Density 2006

General Occurrence

Marine seagrass species observed within the study area included *H. wrightii*, *H. decipiens,* and *H. johnsonii*. Of the 34 transects surveyed in 2006 (Figure 4), marine seagrass species were observed at 25 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 3. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 4).

Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 12 of the 34 transects sampled. Frequency of occurrence values ranged from 0 to 44% with a mean of 23%.

Other species

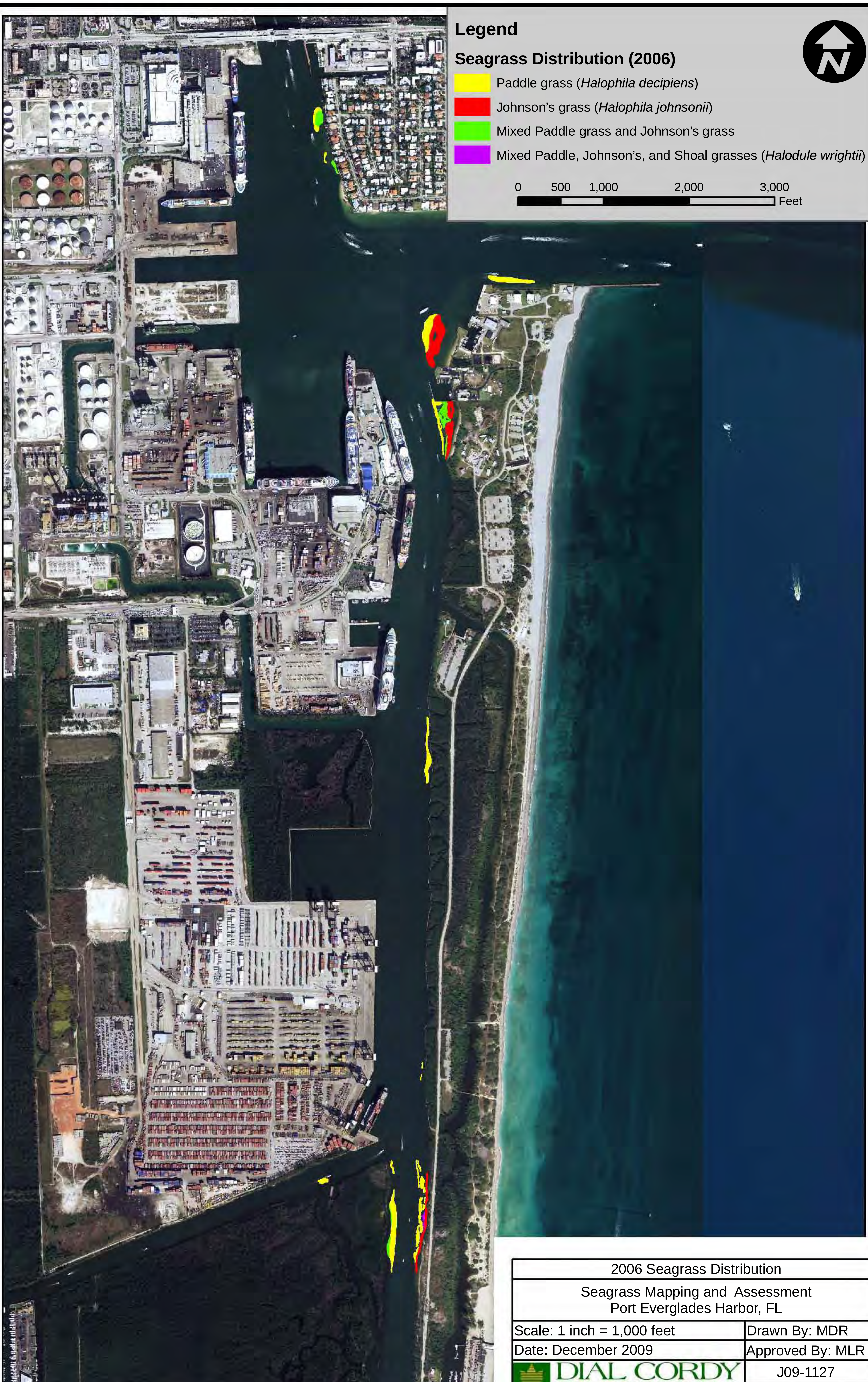
H. decipiens occurred within 20 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 71% with a mean of 22%. In comparison, *H. wrightii* had an occurrence of 5% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 3 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.



2006 Seagrass Distribution

Seagrass Mapping and Assessment
Port Everglades Harbor, FL

Scale: 1 inch = 1,000 feet	Drawn By: MDR
Date: December 2009	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 4

Table 3 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2006 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		**Frequency of Occurrence**			**Abundance**			**Density**		
PE06-1			0.70	0.39		0.84			0.70	
PE06-5			0.05			0.40			0.20	
PE06-6			0.15			0.10			0.07	
PE06-8			0.14	0.14		1.33	0.70		0.33	0.18
PE06-9			0.10	0.16		0.55	0.10		0.09	0.03
PE06-10				0.15			0.10			0.02
PE06-12			0.30	0.20		2.00	2.00		0.80	0.40
PE06-13				0.43			2.00			0.86
PE06-14			0.34	0.44		1.28	2.00		0.89	0.86
PE06-15			0.06			0.10				0.05
PE06-16			0.71			2.67			2.67	
PE06-17			0.06			1.00			0.50	
PE06-20			0.02			0.10			0.03	
PE06-21			0.12			0.10			0.01	
PE06-22			0.17	0.27		2.00	1.00		0.33	0.33
PE06-23			0.04	0.03		0.10	0.10		0.02	0.02
PE06-24		0.05	0.17	0.17	0.10	2.00	2.00	0.02	0.33	0.33
PE06-25			0.08	0.13		0.10	1.00		0.03	0.25
PE06-27			0.11			1.00			0.40	
PE-0631			0.46			1.05			0.70	
PE06-32			0.45			0.10			0.08	
PE06-33			0.23	0.20		0.73	3.00		0.44	0.60

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 34 transects sampled. *H. decipiens* however, had values for cover abundance in the 0.1 to 3 range with a mean of 0.88.

<u>Density</u>

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with values not exceeding an average value of 0.33 per meter squared. The range of density values for *H. johnsonii* was 0 to 0.86.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.67 with an average of 0.43. *H. wrightii* had the lowest densities of the three species with value of 0.02.

3.1.3 Seagrass Species Frequency of Occurrence, Abundance, and Density 2009

<u>General Occurrence</u>

Marine seagrass species observed within the study area included *H. wrightii*, *H. decipiens,* and *H. johnsonii.* Of the 54 transects surveyed in 2009 (Figure 2), marine seagrass species were observed at 36 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 4. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens, H. johnsonii* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii,* monospecific beds of *H. johnsonii,* and monospecific beds of *H. decipiens* (Figure 5).

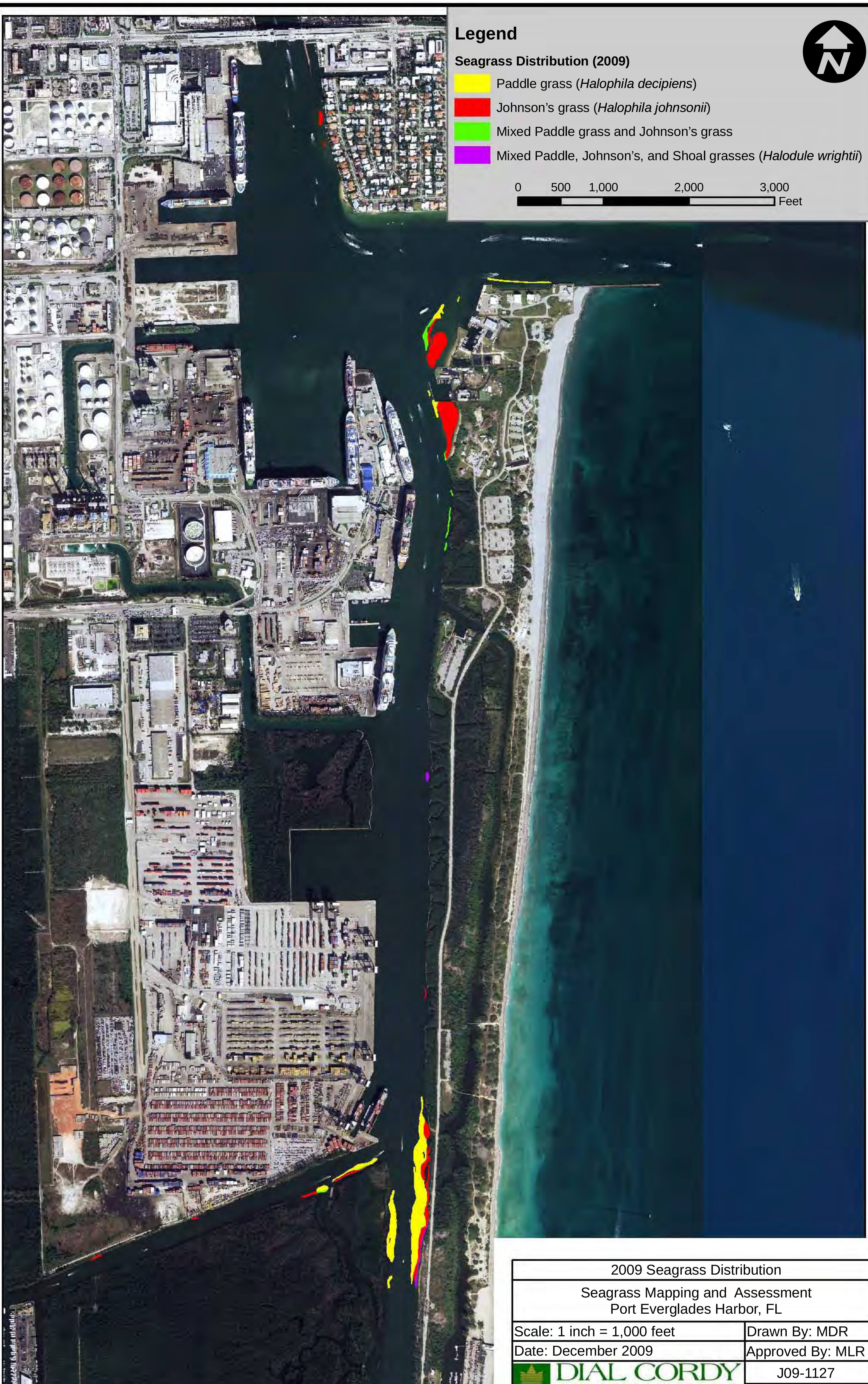
<u>Frequency of Occurrence</u>

H. johnsonii

H. johnsonii occurred within 22 of the 54 transects sampled. Frequency of occurrence values ranged from 0 to 29% with a mean of 8% along transects containing *H. johnsonii*.

Table 4 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2009 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		**Frequency of Occurrence**			**Abundance**			**Density**		
PE-09-03				0.05			1.00			0.40
PE09-35			0.00			0.10			0.00	
PE09-36			0.00			0.40			0.20	
PE09-37			0.00	0.00		1.00	1.00		0.04	0.04
PE09-38				0.15			0.55			0.31
PE09-39				0.00			0.73			0.40
PE09-43				0.17			0.72			0.52
PE09-44				0.21			0.78			0.44
PE09-45				0.10			1.00			0.29
PE09-46			0.01	0.07		1.00	1.00		0.17	0.33
PE09-92			0.02			2.00			0.40	
PE09-93			0.03			1.05			0.30	
PE09-94			0.14	0.29		1.00	0.78		0.33	0.34
PE09-95			0.27			1.03			0.56	
PE09-96			0.42	0.00		1.33	0.10		0.92	0.01
PE09-97			0.04	0.06		1.03	0.40		0.21	0.08
PE09-98			0.13	0.03		0.87	0.55		0.41	0.07
PE09-99			0.11	0.03		3.50	1.00		0.47	0.07
PE09-100			0.30	0.13		0.90	2.50		0.68	0.42
PE09-101			0.40	0.00		2.03	0.10		1.45	0.01
PE09-102		0.07	0.04	0.15	0.10	0.10	1.00	0.02	0.05	0.20
PE09-103			0.33	0.01		1.03	0.10		0.62	0.01
PE09-104			0.05	0.08		0.40	1.00		0.13	0.11
PE09-106			0.12			1.50			0.38	
PE09-108			0.07			0.78			0.39	
PE09-109			0.05			0.55			0.24	
PE09-110			0.17			0.64			0.46	
PE09-111			0.23			1.00			0.50	
PE09-112			0.13			1.00			0.29	
DCC09-02			0.25			1.00			1.00	
DCC09-03			0.05	0.17		0.40	1.00		0.20	0.17
DCC09-04			0.00			0.10			0.02	
DCC09-05			0.01			0.10			0.01	
DCC09-06			0.19			1.50			0.67	
DCC09-07				0.02			1.00			0.10



2009 Seagrass Distribution	
Seagrass Mapping and Assessment Port Everglades Harbor, FL	
Scale: 1 inch = 1,000 feet	Drawn By: MDR
Date: December 2009	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 5

Other species

H. decipiens occurred within 20 out of 54 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 39% with a mean of 13% along transects that contained *H. decipiens*. In comparison, *H. wrightii* had an occurrence of 7% at the single transect where it occurred.

<u>Abundance</u>

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0.1 to 5, where 0.1 is a single shoot, 0.5 is a few shoots, 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover.

H. johnsonii

Abundance values ranged from 0.1 to 3 along transects where *H. johnsonii* occurred. The average abundance for *H. johnsonii* along transects in the Port Everglades area surveyed was 0.8 (< 5% cover). *H. johnsonii* had lower abundance scores than *H. decipiens*.

Other Species

Abundance values ranged from 0.1 to 4 along transects where *H. decipiens* occurred. The average abundance for *H. decipiens* was 1.0 (<5% cover). H. decipiens had the highest abundance of seagrasses surveyed in 2009.Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 49 transects sampled.

<u>Density</u>

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values were low because values were averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for *H. johnsonii* was 0.2 for all transects surveyed that included *H. johnsonii*. The range of density values for *H. johnsonii* across all transects was 0 to 0.5.

Other Species

Halophila decipiens had the highest density values encountered, with a range of 0 to 1 with an average of 0.4. *H. wrightii* had the lowest densities of the three species, at a single transect, with value of 0.02.

3.1.4 Comparison of 1999-2000 to 2009 Seagrass Data

The seagrass communities surveyed in the summer of 2009 within the study area cover a greater area when compared to the 1999-2000 and 2006 seagrass community distribution (Table 5). In general, seagrass beds in the southern portion of the project area have expanded, while seagrass beds to the north of the entrance channel have diminished (Figure 6). Overall, there has been a notable increase in monospecific beds of *H. decipiens* and *H. johnsoni*i; while mixed beds have decreased since 1999-2001. *H. wrightii* cover has decreased since 1999-2000.

Noticeable losses of seagrass have occurred in the northern reaches of the survey area. The area north of the channel has experienced scouring and subsidence due to some action and the associated seagrasses are either no longer there or the beds are greatly reduced in size. This may be from storm events or some other physical disturbance.

The area just south of the channel, near the Coast Guard facility and NOVA Southeastern has increased in seagrass coverage since 1999-2000. The beds near the Coast Guard facility and NOVA Southeastern have transitioned from monospecific beds of *H. johnsonii* (1999-2000) to monospecific beds of *H. johnsonii* and *H. decipiens* in 2006 and 2009. *H. johnsonii* is found in the shallower water, when compared to *H. decipiens*. The predominant seagrass in this area over time has been *H. johnsonii*.

South of the Coast Guard station, adjacent to John U. Lloyd State Park, seagrass cover is low due to the narrow shelf available for seagrass colonization. Near the outlet of the DCC, the shelf widens and provides more available habitat for seagrasses, and from 1999-2000 to 2009 seagrass beds have consistently been documented here. In contrast to beds near the channel inlet, *H. decipiens* is the predominant seagrass, which may be a result of greater depth in this portion of the survey area.

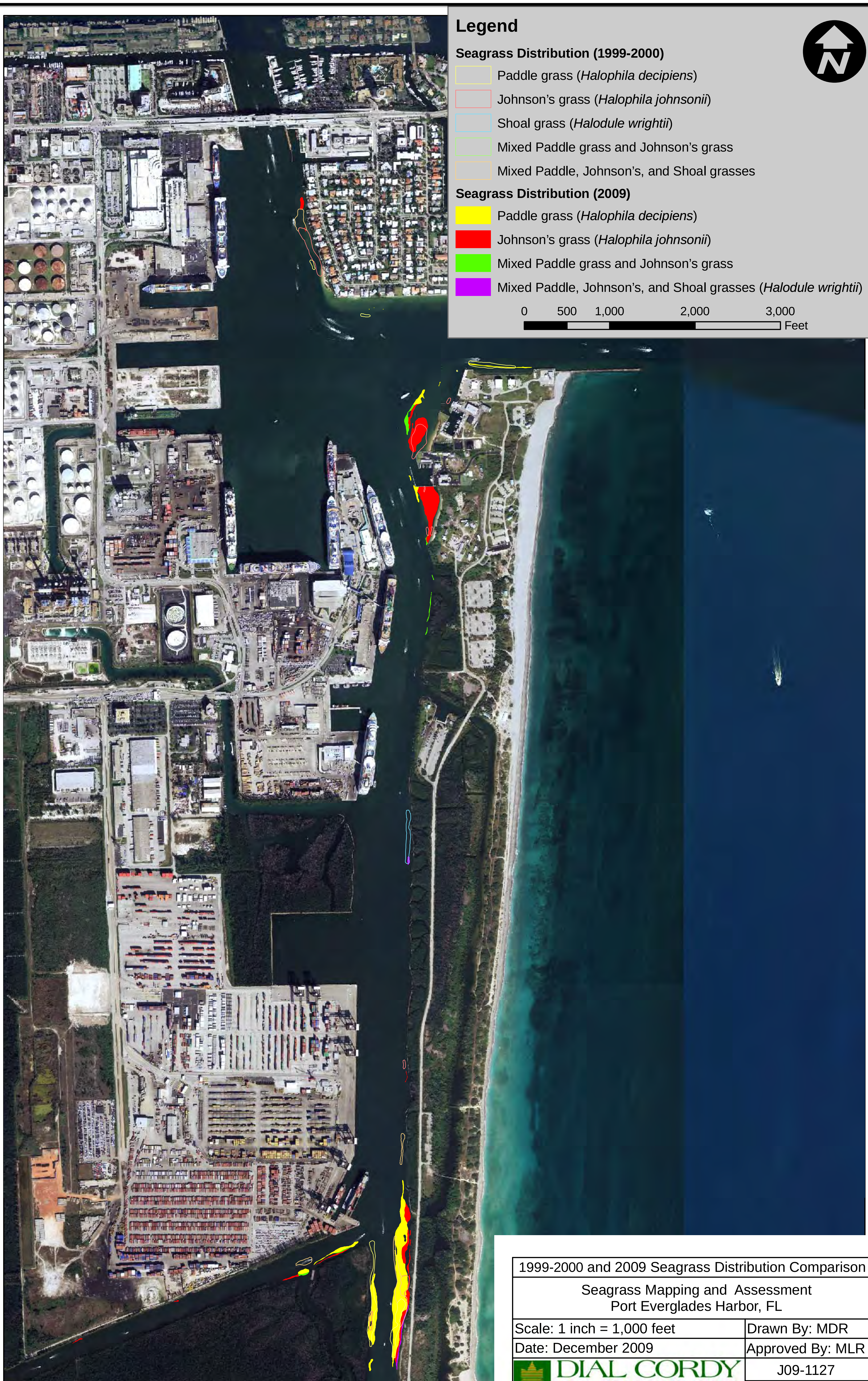
Seagrass cover has increased from 1999-2000 to 2009 within the DCC. Shallow monospecific beds of *H. johnsonii* transition into mixed *H. johnsonii* and *H. decipiens* beds which transition into monospecific beds of *H. decipiens*, across depth.

Frequency of occurrence, abundance and density values are comparable from 1999-2000 to 2009. Many beds have expanded in area coverage over the 10-year survey period, while only a few beds have contracted. Some succession has occurred; most notably with the reduction of *H. wrightii* within the AIWW.

In conclusion, the seagrass communities encountered within the study area were similar in species distribution, while total seagrass coverage has increased since 1999-2000.

Table 5 Comparison of Seagrass Acreage 1999-2000, 2006, and 2009 Port Everglades

Bed Type	1999-2000 Acres	2006 Acres	2009 Acres
H. decipiens	3.29	4.47	6.58
H. johnsonii	2.85	2.80	4.68
H. wrightii	0.61	0.00	0.00
Mixed *H. johjnsonii/H. decipiens*	0.00	1.08	0.46
Mixed *H.decipiens/H.johsonii/H. wrightii*	1.96	0.09	0.26
Totals	**8.71**	**8.44**	**11.98**



1999-2000 and 2009 Seagrass Distribution Comparison	
Seagrass Mapping and Assessment Port Everglades Harbor, FL	
Scale: 1 inch = 1,000 feet	Drawn By: MDR
Date: December 2009	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J09-1127
	Figure 6

4.0 REFERENCES

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Seagrass Mapping and Assessment
Port Everglades Harbor

Final Report

October 5, 2006

Prepared for:
U.S. Army Corps of Engineers
Jacksonville District
701 Prudential Drive
Jacksonville, FL 32207

Prepared by:
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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was originally subcontracted by Gulf Engineers and Consultants, Inc. (GEC) to conduct an environmental baseline and impact assessment for proposed deepening and widening of Port Everglades, Broward County, FL for the U.S. Army Corps of Engineers, Jacksonville District (Corps), under contract No. DACW17-99-D-0043 in 1999. Data was collected in an initial seagrass survey in 1999 (DC&A 1999). That study included baseline mapping of seagrasses within the project area at Port Everglades and the results are found in Dial Cordy 2001.

In 2006, the Corps contracted DC&A to revisit Port Everglades and re-survey the seagrass to document any changes that my have occurred to seagrass communities in the preceding five to six years. The data collected during this study and related composite resource maps are summarized in this report.

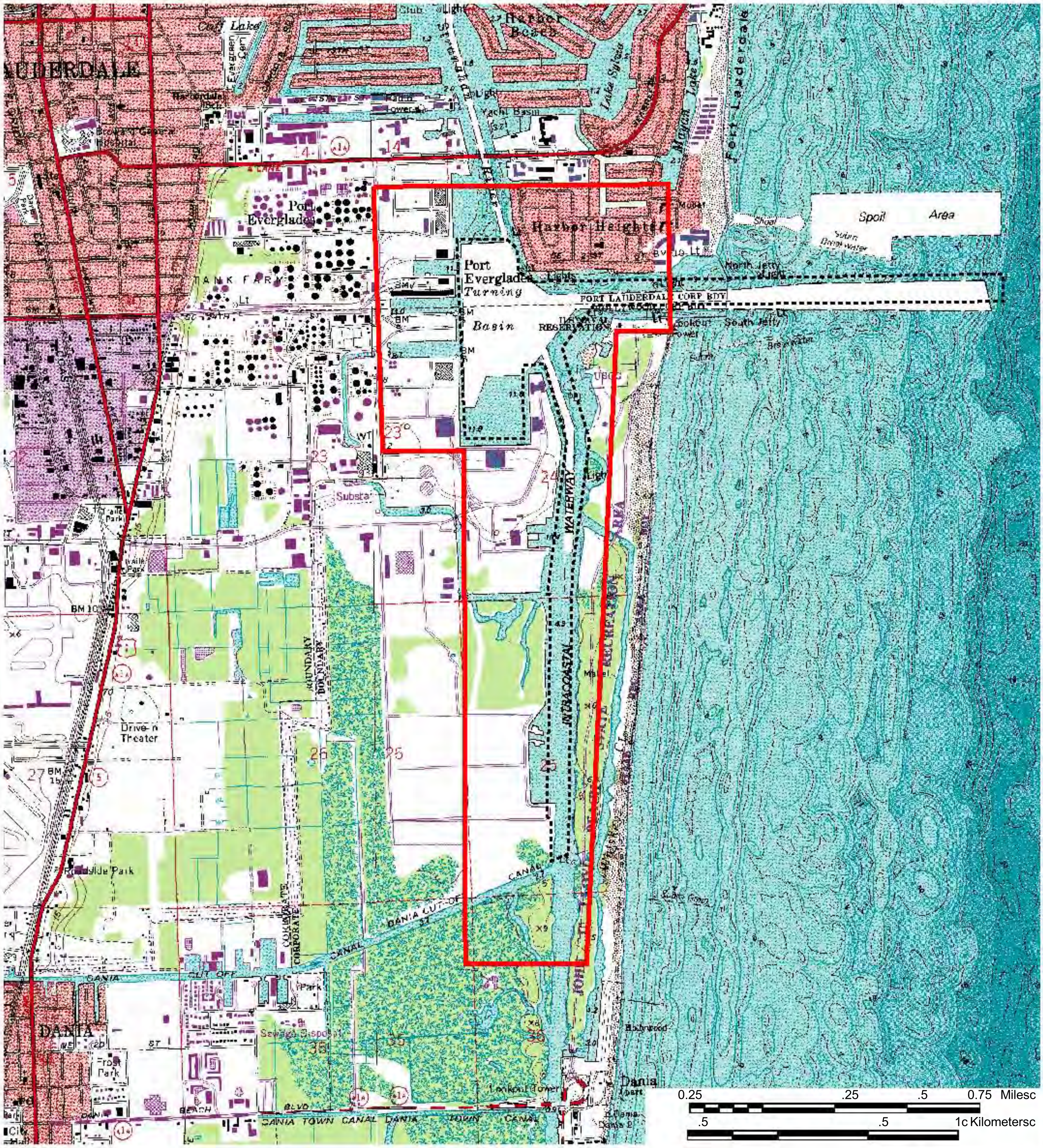
Halophila johnsonii was listed as a threatened species by NMFS on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the AIWW south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within the area considered for widening and deepening.

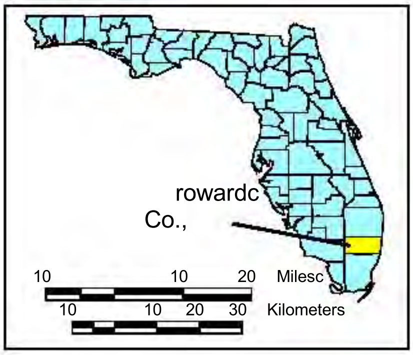
2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study. Previous resource surveys were conducted in late summer 1999 and 2000, and in May 2001. The most current data was collected in June 2006.

2.1 Marine Resource Survey

A description of methods utilized to document and characterize marine seagrass communities within the study area (Figure 1) are described below. Surveys were conducted on September 6-10, 1999, September 19-21, 2000, May 16-17, 2001 and June 22-25, 2006 (DC&A 1999, 2001).





Extent of Survey Areac
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ocation of Study Areac	
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DIAL CORDY AND ASSOCIATES INC Environmental Consultants	Figure 1c

2.2.1 Seagrass Community

Descriptions of methods used to assess seagrass communities within the Port area are included in this section.

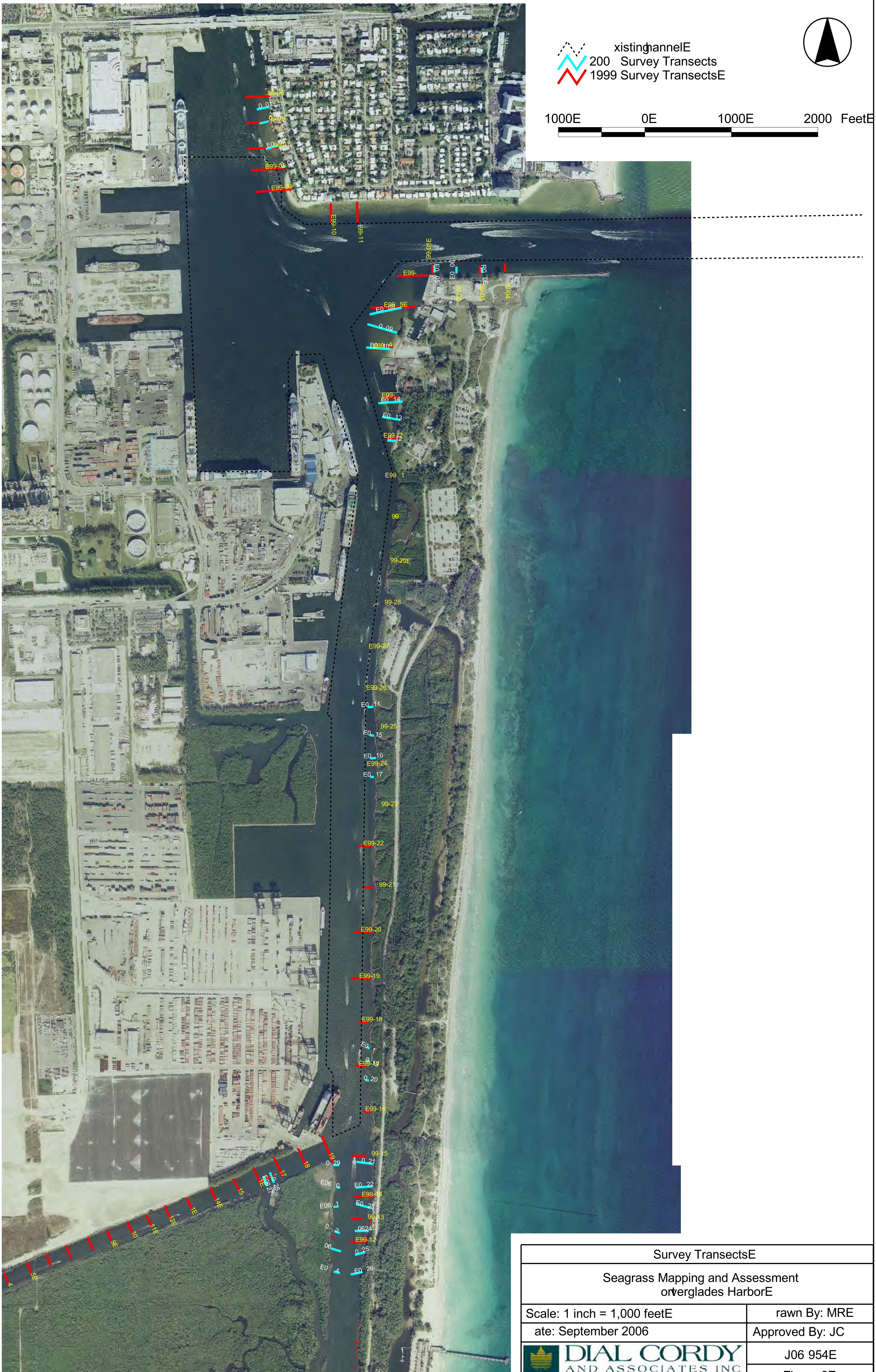
2.2.1.1 Location of Survey Transects

The location of survey transects for the 1999 survey ranged from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 2). The most current survey included the locations surveyed in 1999, namely from about 1200 feet north of the Port Everglades Inlet south past the DCC and along the DCC to Port Denison.

2.2.1.2 Seagrass Mapping

In 1999 marine seagrass distribution was mapped along 62 transects by locating the end positions using Differential Global Positioning System (DGPS), laying a weighted line marked in one meter increments from the shore, and then conducting a visual diver survey along the weighted line to document seagrass distribution and occurrence from the shore to the edge of channel. Seagrass habitat and bottom type observed while crossing each transect were noted. Divers drift dove to the next transect, and if any seagrass was found between transects, a GPS position at the start and end of the grass bed was recorded, and the width of the grass bed estimated. Information recorded on seagrass habitat type and distribution was transferred from field logs and entered into a spreadsheet. Descriptions of habitat classifications are shown in Table 1. This approach allowed a visual representation of species' associations and occurrences across the shelf, channel, and slope as compared with bottom depth. Maps were produced for all stations surveyed that had seagrass present. A GIS map (ArcView) and database were created to illustrate seagrass distributions throughout the study area.

Similar methods were used in the 2006 surveys. Since baseline seagrass maps now existed for the area, a reconnaissance of the area was performed first. Divers swam the entire shoreline of the study area noting the occurrence of seagrass beds and recording each occurrence in real time with the DGPS and HYPACK software. This allowed the survey team to roughly assess the current distribution of grasses in the study area. Then seagrass transects were established in the areas where grass occurred to assess the coverage, abundance and density. In total 26 seagrass transects were established in 2006. Transect locations were spaced similarly to the previous surveys and care was taken to include transects that would encompass all of the beds encountered.



Survey TransectsE

Seagrass Mapping and Assessment
ortverglades HarborE

Scale: 1 inch = 1,000 feetE	rawn By: MRE
ate: September 2006	Approved By: JC
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J06 954E
	Figure 2E

2.2.1.3 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the location, occurrence, abundance, and density of marine seagrass, a SCUBA point intercept survey was performed along each transect. For each transect, the average percent (percent of sixteen 25 x 25 cm sub-units within a $1m^2$ quadrat that contains at least one seagrass shoot) was estimated in $1m^2$ quadrats at 10m intervals along the transect line (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful. The cover abundance scale is discussed below.

The cover abundance scale was computed beginning at the zero point and at 10m intervals along each transect. The content of each quadrat was visually assessed and a cover abundance scale value assigned to the seagrass coverage.

Table 1 Habitat Classification System Used for Mapping of Seagrass Species

Habitat Types	Description
Halophila decipiens	Monospecific bed of this species
Halophila johnsonii	Monospecific bed of this species
Halodule wrightii	Monospecific bed of this species
Syringodium filiforme	Monospecific bed of this species
Mixed Submerged Aquatic Vegetation	*S. filiforme or H. wrightii* with *H. decipiens*
Mixed Submerged Aquatic Vegetation with *H. johnsonii*	*S. filiforme* and or *H. wrightii* with *H. johnsonii*
Mixed Submerged Aquatic Vegetation with *H. johnsonii* and *H. decipiens*	*H. wrightii* with both species of *Halophila*
Unvegetated Bottom	Sand, silt or shell substrate with no seagrass or live bottom, may have marine algae present
Live-Bottom Habitat	Sponge and soft coral community over thin veneer of silty-sand

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover

From the survey of quadrats along each transect, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.2.1.4 Analysis and Interpretation of Seagrass Data

Distribution of seagrass community types and their potential occurrence in an area were mapped for each transect from survey data. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

This section includes a description and review of the results of the marine resources survey. It outlines the findings of the seagrass community survey, including species occurrence, abundance, and density for both the previous surveys and the most current sampling event.

3.1 Seagrass Communities

Seagrass habitat cover type, abundance, and density for the study area are described below. Distribution and occurrence observations for the 1999 survey range from approximately 1200 feet north of Port Everglades Inlet south to about 1000 feet south of the DCC and along the DCC to Port Denison (Figure 2) (DC&A 1999). To field verify whether seagrass occurred in the Outer Entrance Channel (OEC), as reported by the Broward County Department of Planning and Environmental Protection (DPEP) staff (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County), an integrated video survey was performed in 2001 within the federal channel.

3.1.1 Seagrass Species Frequency of Occurrence, Abundance, and Density 1999-2001

General Occurrence

Marine seagrass species observed within the study area included *Halodule wrightii, Halophila decipiens*, and *Halophila johnsonii.* Of the 62 transects surveyed in 1999 and 2000 (Figure 2), marine seagrass species were observed at 19 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 2. DPEP divers documented the occurrence of *H. decipiens* within the OEC (Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). Video surveys within the channel confirmed the presence of isolated patchy beds of *H. decipiens* in 45 feet of water.

Seagrass occurrence within the interior areas consisted of mixed Submerged Aquatic Vegetation (SAV) with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 3).

Frequency of Occurrence

H. johnsonii

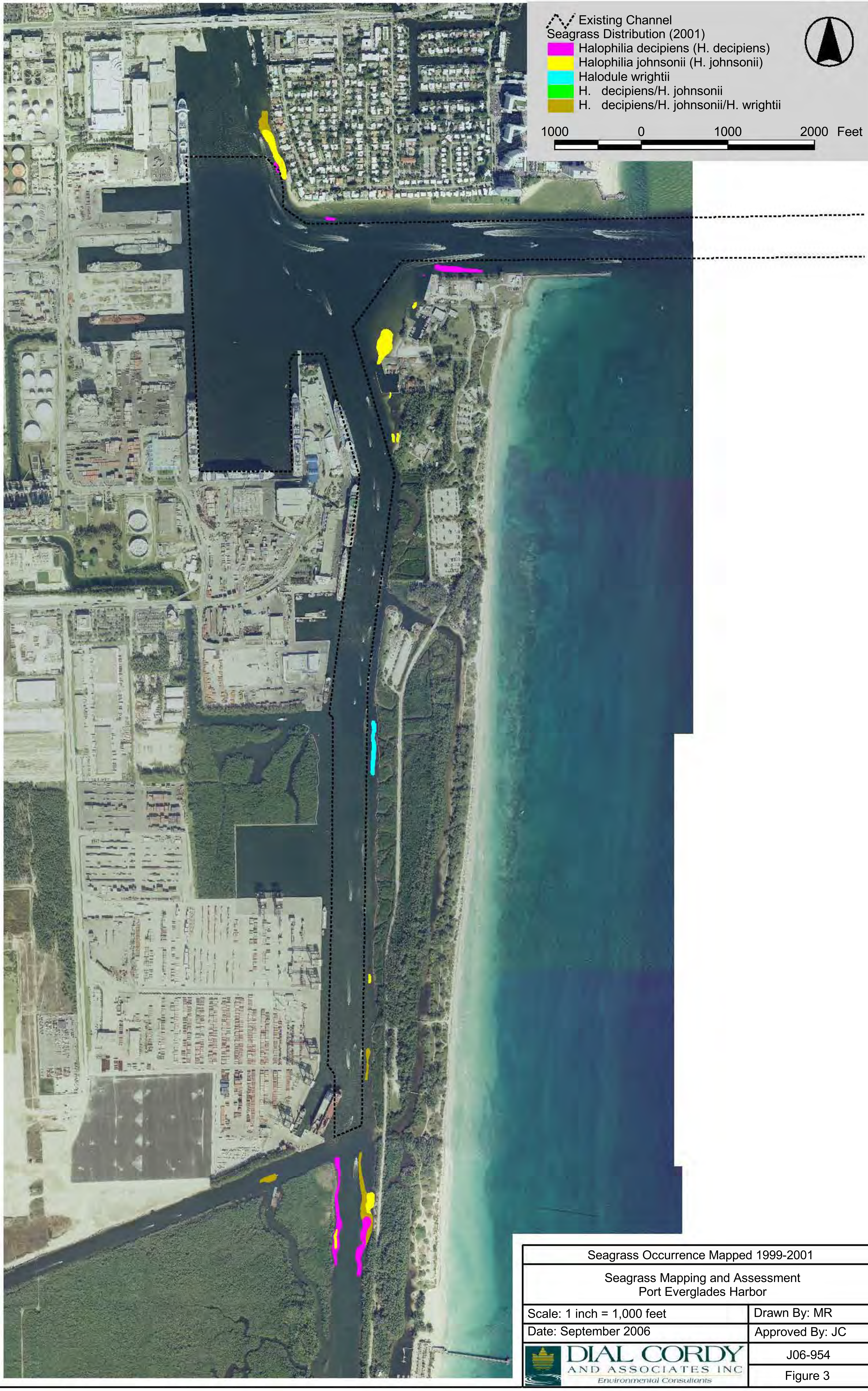
H. johnsonii occurred within 11 of the 62 transects sampled. Frequency of occurrence values ranged from 0 to 25% with a mean of 11%.

Other species

H. decipiens occurred within 11 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 67% with a mean of 12%. In comparison, *H. wrightii* had a range of occurrence values between 0 to 24% with a mean of 8% over the study area.

Abundance

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover



Seagrass Occurrence Mapped 1999-2001	
Seagrass Mapping and Assessment Port Everglades Harbor	
Scale: 1 inch = 1,000 feet	Drawn By: MR
Date: September 2006	Approved By: JC
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J06-954
	Figure 3

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 4 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 4 of the 62 transects sampled. The abundance values ranged from 0.1 to 1.5 with a mean 0.34. *H. decipiens* however, had values for cover abundance in the 0.1 to 5.0 range with a mean of 0.65.

Table 2 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 1999-2000 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		**Frequency of Occurrence**			**Abundance**			**Density**		
PE99-1			0.09			0.30			0.15	
PE99-2			0.34			1.25			0.63	
PE99-3			0.02			0.10			0.03	
PE99-6			0.07	0.14		0.30	1.05		0.10	0.35
PE99-7				0.18			0.55			0.22
PE99-8			0.08	0.05		0.50	0.10		0.13	0.03
PE99-10			0.04			0.10			0.01	
PE99-12			0.03	0.15		0.10	0.87		0.05	0.43
PE99-13		0.23		0.17	1.00		2.00	0.40		0.40
PE99-14		0.02	0.06	0.03	0.10	0.50	0.10	0.01	0.06	0.03
PE99-15			0.01	0.02		0.10	0.10		0.02	0.02
PE99-17				0.15			1.00			0.33
PE99-24		0.13			0.50			0.25		
PE99-25		0.06			0.10			0.05		
PE99-32				0.23			1.75			0.70
PE99-34				0.25			1.02			0.64
PE99-35				0.01			0.10			0.02
PE99-36			0.01			0.10			0.01	
DCOC-16			0.03			0.10			0.03	

Density

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low compared to abundance because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with an average value of 0.32 per meter squared. The range of density values for *H. johnsonii* was 0 to 1.0.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.50 with an average of 0.32. *H. wrightii* had the lowest densities of the three species with values ranging from 0 to 0.75 with a mean of 0.15.

3.1.2 Seagrass Species Frequency of Occurrence, Abundance, and Density 2006

General Occurrence

Marine seagrass species observed within the study area included *H. wrightii*, *H. decipiens*, and *H. johnsonii*. Of the 34 transects surveyed in 2006 (Figure 2), marine seagrass species were observed at 25 transects. A summary of occurrence records for each transect where seagrass was found is given in Table 3. Seagrass occurrence within the study areas consisted of mixed beds with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and monospecific beds of *H. decipiens* (Figure 4).

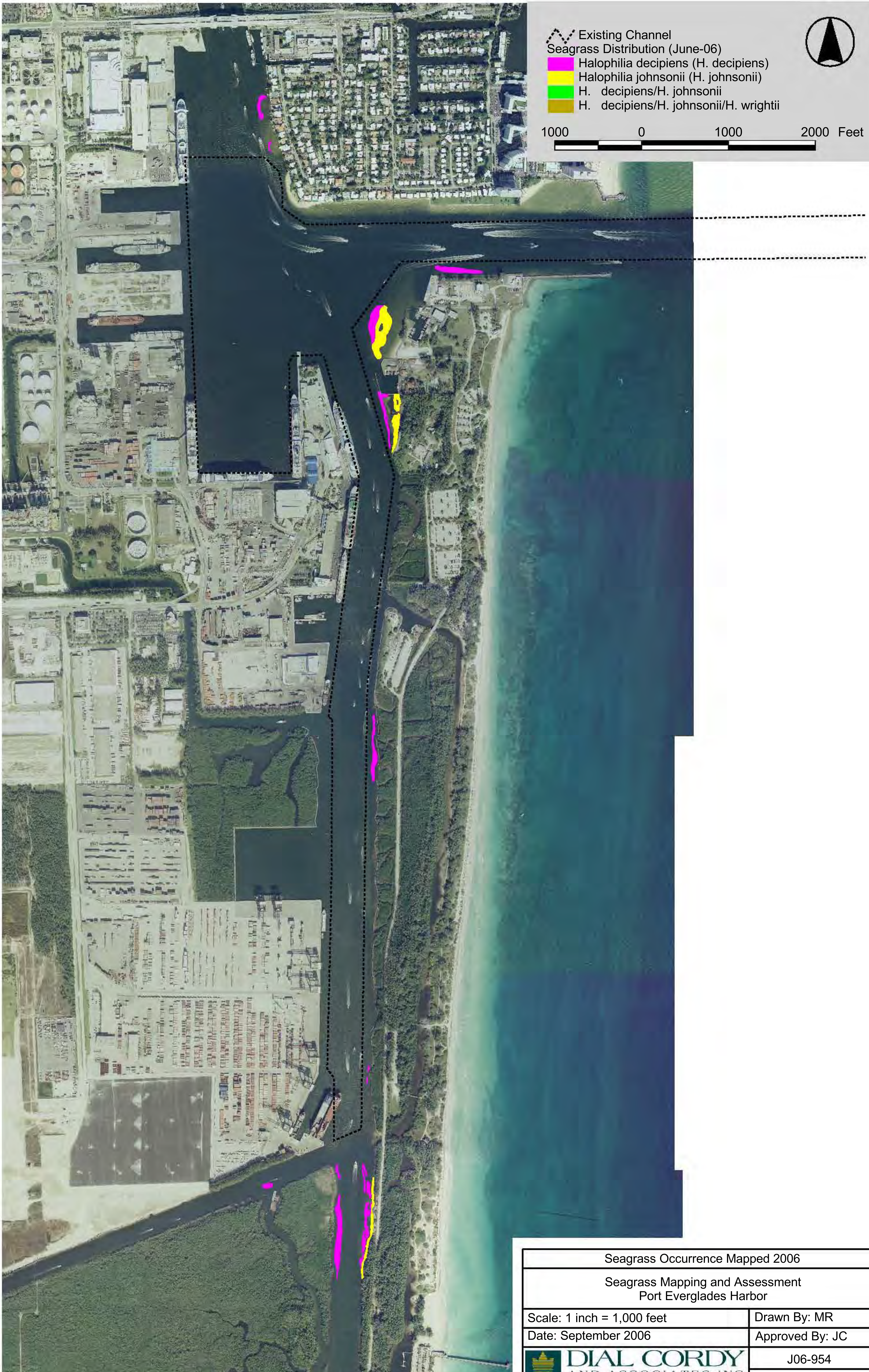
Frequency of Occurrence

H. johnsonii

H. johnsonii occurred within 12 of the 34 transects sampled. Frequency of occurrence values ranged from 0 to 44% with a mean of 23%.

Table 3 Seagrass Frequency of Occurrence, Abundance, and Density Values for Port Everglades Survey Transects for 2006 Survey

		Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii	Halodule wrightii	Halophila decipiens	Halophila johnsonii
Transect		Frequency of Occurrence			Abundance			Density		
PE06-1			0.70	0.39		0.84			0.70	
PE06-5			0.05			0.40			0.20	
PE06-6			0.15			0.10			0.07	
PE06-8			0.14	0.14		1.33	0.70		0.33	0.18
PE06-9			0.10	0.16		0.55	0.10		0.09	0.03
PE06-10				0.15			0.10			0.02
PE06-12			0.30	0.20		2.00	2.00		0.80	0.40
PE06-13				0.43			2.00			0.86
PE06-14			0.34	0.44		1.28	2.00		0.89	0.86
PE06-15			0.06			0.10				0.05
PE06-16			0.71			2.67			2.67	
PE06-17			0.06			1.00			0.50	
PE06-20			0.02			0.10			0.03	
PE06-21			0.12			0.10			0.01	
PE06-22			0.17	0.27		2.00	1.00		0.33	0.33
PE06-23			0.04	0.03		0.10	0.10		0.02	0.02
PE06-24		0.05	0.17	0.17	0.10	2.00	2.00	0.02	0.33	0.33
PE06-25			0.08	0.13		0.10	1.00		0.03	0.25
PE06-27			0.11			1.00			0.40	
PE-0631			0.46			1.05			0.70	
PE06-32			0.45			0.10			0.08	
PE06-33			0.23	0.20		0.73	3.00		0.44	0.60



Seagrass Occurrence Mapped 2006	
Seagrass Mapping and Assessment Port Everglades Harbor	
Scale: 1 inch = 1,000 feet	Drawn By: MR
Date: September 2006	Approved By: JC
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J06-954
	Figure 4

Other species

H. decipiens occurred within 20 transects sampled. Frequency of occurrence for *H. decipiens* values ranged between 0 to 71% with a mean of 22%. In comparison, *H. wrightii* had an occurrence of 5% over the study area.

<u>Abundance</u>

Abundance is expressed as a sum of the cover abundance scores divided by the number of quadrats where the specific species was assigned a score. Scores range from 0 to 5, where 1.0 is <5% cover, 2.0 is 5 to 25% cover, 4.0 is 50 to 75% cover, and 5.0 is >75% cover

H. johnsonii

Abundance values for *H. johnsonii* ranged from 0 to 3 for transects sampled. The average abundance for *H. johnsonii* in the Port Everglades area surveyed was 1.1 (< 5% cover). *H. johnsonii* had the highest abundance values of all species over all transects.

Other Species

Cover abundance for *H. wrightii* was low as it only occurred in 1 of the 34 transects sampled. *H. decipiens* however, had values for cover abundance in the 0.1 to 3 range with a mean of 0.88.

<u>Density</u>

Density is expressed as the sum of the cover abundance scores divided by the total quadrats sampled. When compared to abundance values, density values are very low compared to abundance because values are averaged across all quadrats within each transect, rather than only at occupied quadrats.

H. johnsonii

Density for this species was the highest of all species in the study area, with values not exceeding an average value of 0.33 per meter squared. The range of density values for *H. johnsonii* was 0 to 0.86.

Other Species

Halophila decipiens had the second highest density values encountered, with a range of 0.01 to 2.67 with an average of 0.43. *H. wrightii* had the lowest densities of the three species with value of 0.02.

3.1.3 Comparison of 1999 to 2006 Seagrass Data

The seagrass communities encountered in June 2006 within the study area are very similar in composition to the seagrass communities encountered in the previous sampling events. Some loss and succession within these seagrass communities has occurred, but overall the condition and location of the seagrass beds has remained largely unchanged. Table 4 shows the break down of seagrass type by acreage for the previous surveys (1999-2001) compared to the most recent survey. Overall, only a 0.3-acre reduction in seagrass is noted with the entire project area. Some succession, expansion and losses have seagrasses have occurred, but overall the acreage remains almost the same.

Noticeable losses have seagrass have occurred in the northern reaches of the survey area. The area north of the channel has experienced scouring and subsidence due to some action and the associated seagrasses are either no longer there or the beds are greatly reduced in size. This may be from storm events or some other activity within the Port.

The area near the Coast Guard facility has seen an increase in seagrass coverage since 1999. This is particularly true in the area just south of the Coast Guard basin. The H. johnsonii beds near the entrance of the Coast Guard basin have also expanded in the last 5 years.

Frequency of occurrence, abundance and density numbers are very comparable over the span of the surveys conducted. No noticeable changes in density or abundance have occurred within persistent beds. Some succession has occurred; most notably with the reduction in *H. wrightii* is some locations. In at least one location *H. wrightii* appears to have been replaced almost entirely with *H. decipiens*.

Table 4 Comparison of Seagrass Acreage1999 to 2006 Port Everglades

Bed Type	1999-2001 Acres	2006 Acres
H. decipiens	3.29	4.47
H. johnsonii	2.85	2.80
H. wrightii	0.61	0.00
Mixed *H. johjnsonii/H. decipiens*	0.00	1.08
Mixed *H.decipiens/H.johsonii/H. wrightii*	1.96	0.09
Totals	**8.71**	**8.44**

In conclusion, the seagrass communities encountered within the study area are very similar to those encountered originally in 1999. Some changes in community structure have occurred, but overall the location and density of seagrasses throughout Port Everglades have remained constant. Some losses have occurred, particularly in the northern extents of the study area. These losses are most likely attributed to loss of material due to erosion during the previous two seasons' storm events.

4.0 REFERENCES

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Seagrass Mapping and Assessment – Between the Nearshore Hardbottom and Middle Reef on the South Side of Port Everglades Entrance Channel

Final Report

September 2013

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1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A) was contracted by David Miller and Associates (DMA) to conduct a seagrass survey for the area between the nearshore hardbottom and middle reef adjacent to the south side of the Port Everlglades entrance channel and to document the presence and extent of a previously known seagrass bed west of the nearshore hardbottom, also on the south side of the entrance channel (Figure 1).

Broward County and federal and state regulators conducted qualitative seagrass surveys in the area of the Port Everglades outer entrance channel in July 2013 and took GPS points at two locations (BC1 and BC2) that defined the edge of a seagrass bed between the nearshore hardbottom and middle reef. *Halophila decipiens* was identified as present within the seagrass bed, and members of the dive suggested that *H. johnsonii* may also have been present. Therefore, a survey method consistent with the Johnson's seagrass protocol was justified (NMFS 2002).

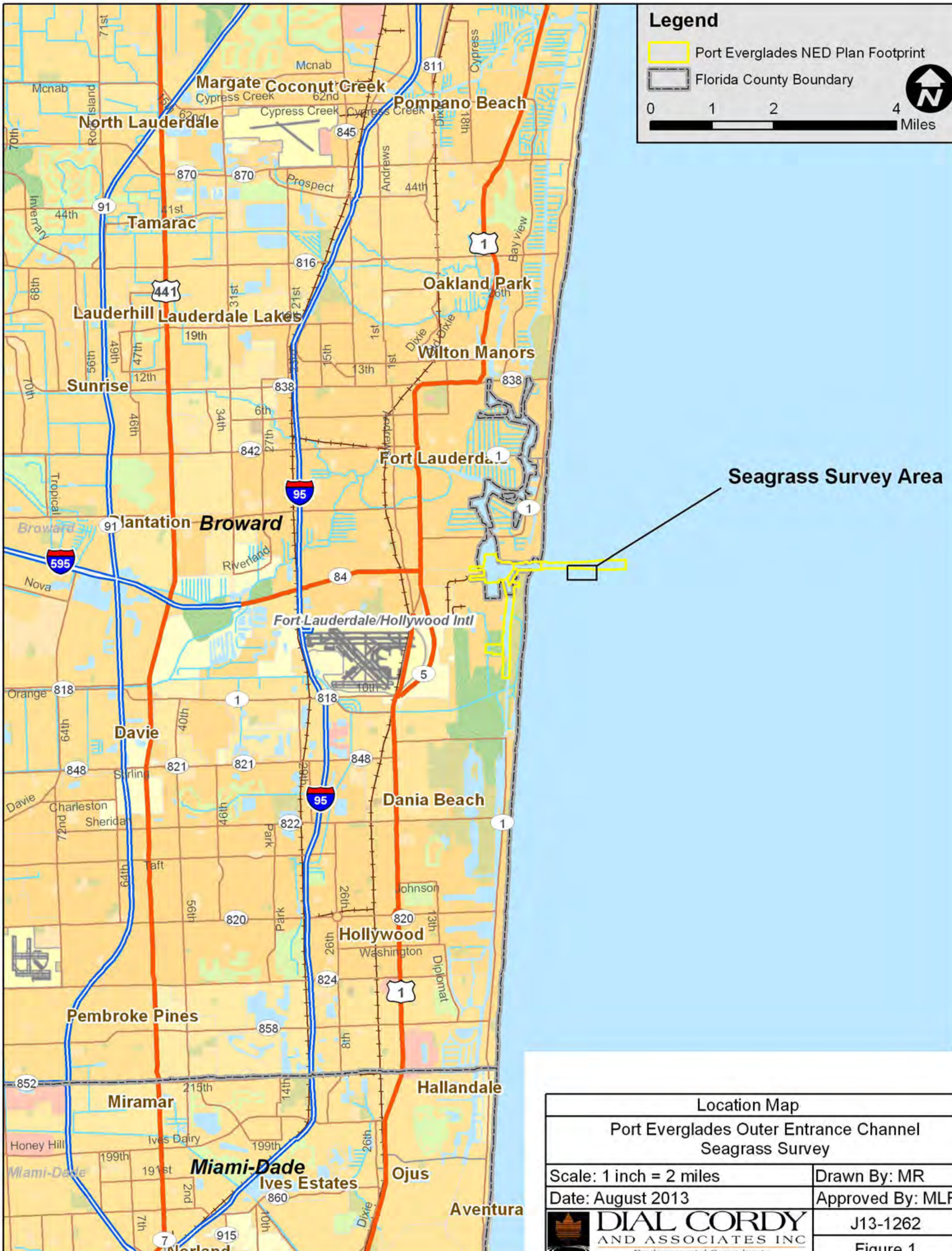
Halophila johnsonii was listed as a threatened species by National Marine Fisheries Service (NMFS) on September 14, 1998 (63 FR 49035) and a re-proposal to designate critical habitat pursuant to Section 4 of the Endangered Species Act (ESA) was published on December 2, 1998 (64 FR 64231). The final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (Federal Register, vol. 65, No. 66). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. It is only known to occur between Sebastian Inlet and northern Biscayne Bay on the east coast of Florida (Kenworthy 1997). As stated in earlier reports (DC&A 1999) and the findings of this survey, *H. johnsonii* occurs within the Atlantic Intracoastal Waterway (AIWW) south of the turning basin for Port Everglades, in the Dania Cut-Off Canal (DCC), and within portions of the harbor area considered for federal civil works widening and deepening.

2.0 TECHNICAL APPROACH

This section describes the technical approach used to collect and analyze data associated with the environmental baseline study.

2.1 Seagrass Survey

Seagrass survey methods were consistent with the *Halophila johnsonii* Final Recovery Plan (NMFS 2002), which describes suggested survey methods for sampling *H. johnsonii*. The protocol for large sites (> 1 hectare) was used to delineate and qualitatively and quantitatively assess the seagrass bed documented by Broward County in July 2013 (NMFS 2002). The seagrass bed is located between the nearshore hardbottom and middle reef, adjacent to the southern boundary of the Port Everglades outer entrance channel.



Location Map	
Port Everglades Outer Entrance Channel Seagrass Survey	
Scale: 1 inch = 2 miles	Drawn By: MR
Date: August 2013	Approved By: MLR
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J13-1262
	Figure 1

Seagrass surveys were completed August 28-30, 2013. Weather conditions were excellent, with 0-2m seas, clear skies, and good to excellent water clarity. Underwater visibility was 25-100 feet during the seagrass survey, depending on current and tide conditions.

A tiered approach was used to delineate the seagrass bed between the nearshore hardbottom and middle reef (NMFS 2002). First, divers were towed along nine transects to delineate the boundaries of the seagrass bed. Nine transects were spaced 25m apart and oriented in a north to south direction (Figure 2). The existing channel was the northern boundary of the survey area and the southern boundary of the survey area was defined by visual observation of the end of the seagrass bed. In order to gain an understanding of the dimensions of the seagrass bed, which was initially reported to be large, towed divers with communications between the divers and the topside vessel were used. Divers were towed on a line, set back 50 feet (15 meters) from the vessel. Divers were towed at <1 knot and maintained a depth of approximately 1m above the bottom. Divers were able to control depth using a planar board and could descend to look closely at the benthic community in order to identify seagrass species. A tenth transect was surveyed to document the presence of a seagrass bed that had been previously documented west of the nearshore hardbottom (Figure 2).

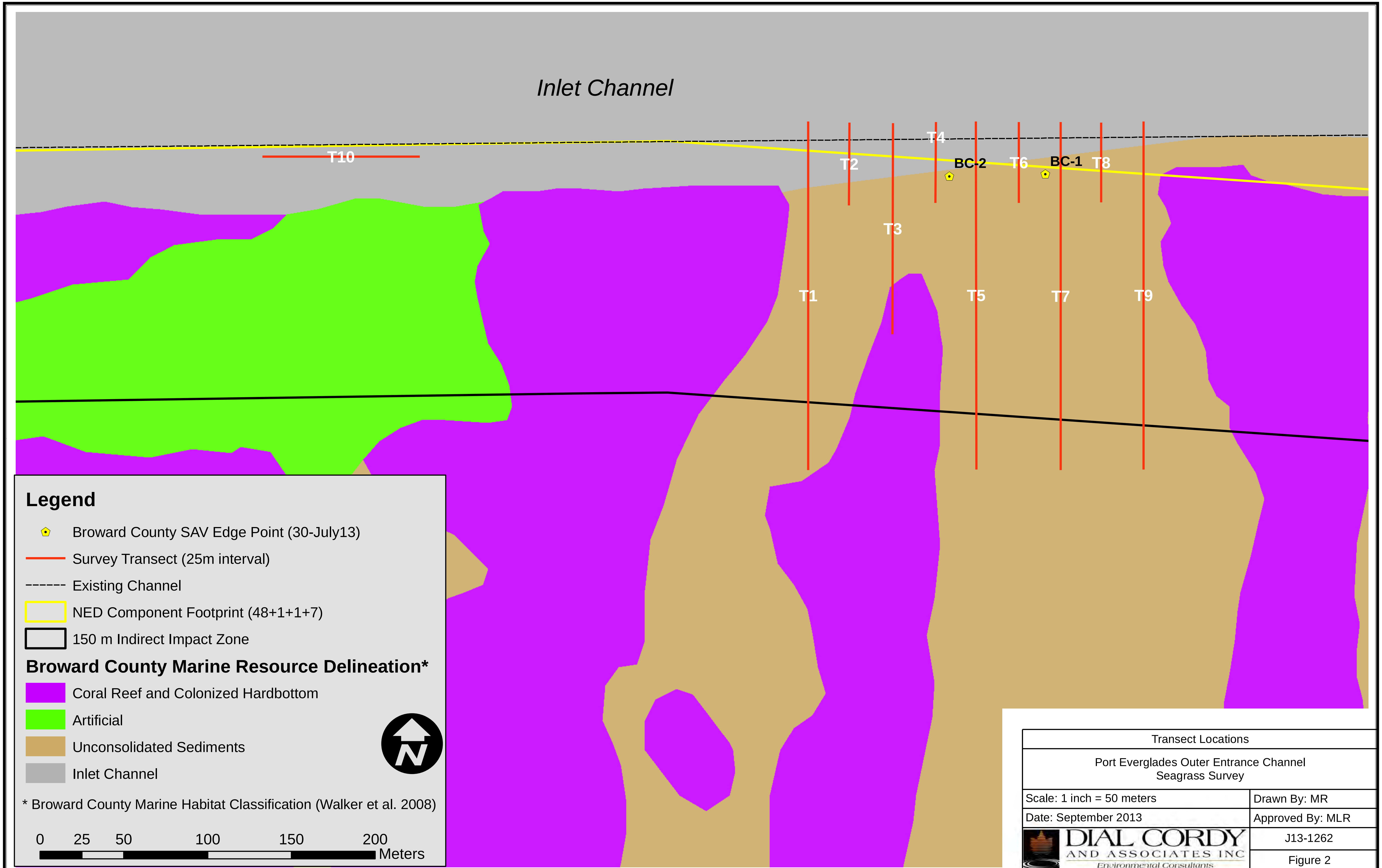
After the towed divers delineated the extent of the seagrass bed between the nearshore hardbototm and middle reef, divers were deployed to photograph and quantitatively survey the seagrass bed at two locations, BB1 and BB2 (Figure 3).

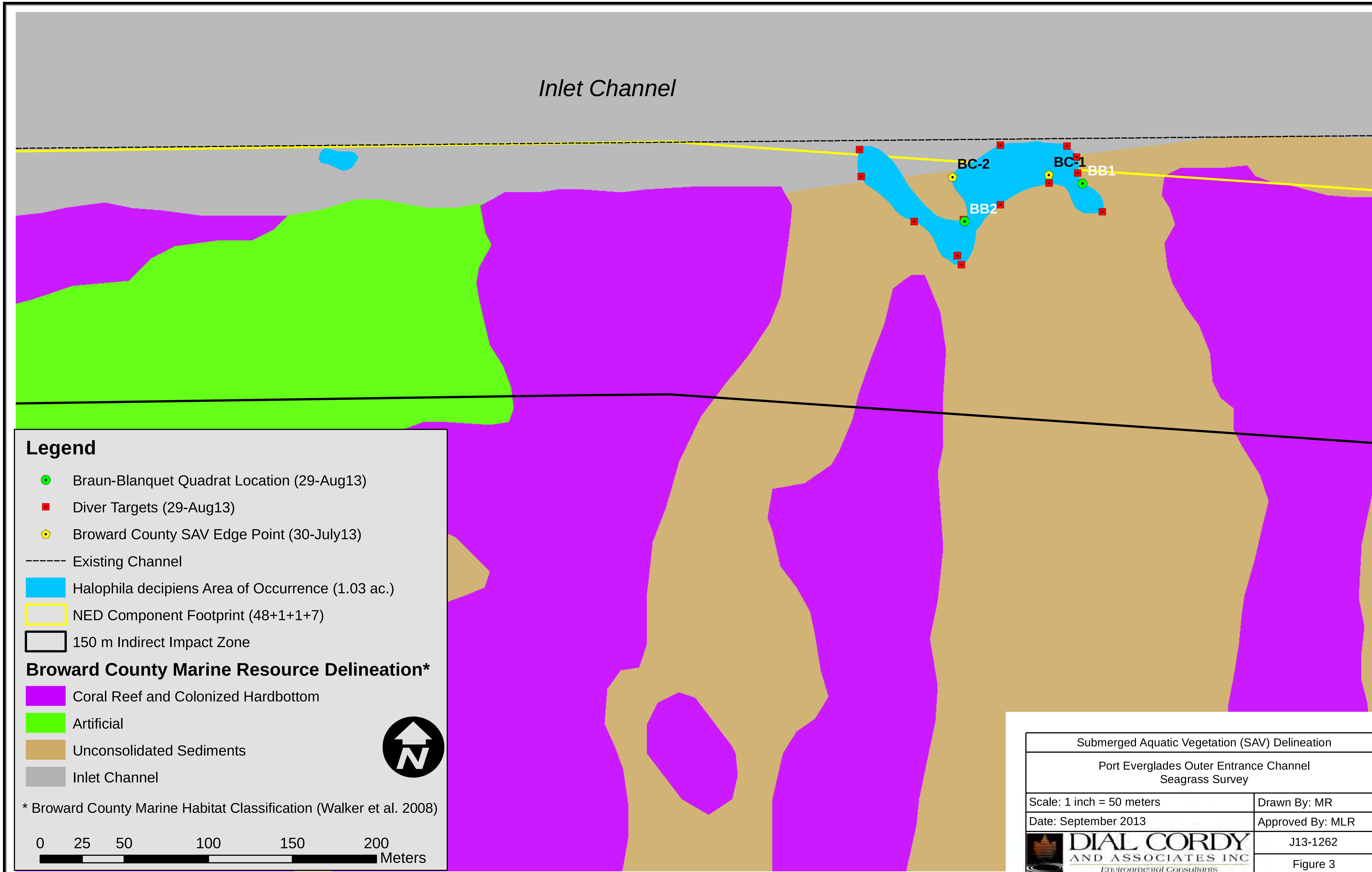
2.1.1 Seagrass Occurrence, Abundance, and Density

To obtain biological data regarding the occurrence, abundance, and density of marine seagrass, $1m^2$ quadrats were deployed in two locations (BB1 and BB2). The chosen sampling locations were identified during transect surveys as areas of the highest density and greatest continuous seagrass. Fifteen quadrats were sampled at BB1 and 13 quadrats were sampled at BB2. Specific data recorded within each $1m^2$ quadrat for each seagrass species present included the number of sub-units (100 possible) containing at least one shoot, an average cover abundance score (Braun-Blanquet 1965), a description of substrate type, and any other observations considered useful (Virnstein 1995; Fonseca et al. 1998; Braun-Blanquet 1965). The cover abundance scale is discussed below.

The scale values are:

0.1 = Solitary shoots with small cover
0.5 = Few shoots with small cover
1.0 = Numerous shoots but less than 5% cover
2.0 = Any number of shoots but with 5-25% cover
3.0 = Any number of shoots but with 25-50% cover
4.0 = Any number of shoots but with 50-75% cover
5.0 = Any number of shoots but with >75% cover


Inlet Channel
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
BC-2
BC-1
Legend
Broward County SAV Edge Point (30-July13)
Survey Transect (25m interval)
Existing Channel
NED Component Footprint (48+1+1+7)
150 m Indirect Impact Zone
Broward County Marine Resource Delineation*
Coral Reef and Colonized Hardbottom
Artificial
Unconsolidated Sediments
Inlet Channel
* Broward County Marine Habitat Classification (Walker et al. 2008)
0 25 50 100 150 200
Meters
N
Transect Locations
Port Everglades Outer Entrance Channel
Seagrass Survey
Scale: 1 inch = 50 meters
Drawn By: MR
Date: September 2013
Approved By: MLR
DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants
J13-1262
Figure 2


Inlet Channel
BC-2
BC-1
BB1
BB2
Legend
Braun-Blanquet Quadrat Location (29-Aug13)
Diver Targets (29-Aug13)
Broward County SAV Edge Point (30-July13)
Existing Channel
Halophila decipiens Area of Occurrence (1.03 ac.)
NED Component Footprint (48+1+1+7)
150 m Indirect Impact Zone
Broward County Marine Resource Delineation*
Coral Reef and Colonized Hardbottom
Artificial
Unconsolidated Sediments
Inlet Channel
N
* Broward County Marine Habitat Classification (Walker et al. 2008)
0 25 50 100 150 200
Meters
Submerged Aquatic Vegetation (SAV) Delineation
Port Everglades Outer Entrance Channel
Seagrass Survey
Scale: 1 inch = 50 meters
Drawn By: MR
Date: September 2013
Approved By: MLR
DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants
J13-1262
Figure 3

From the survey of quadrats, frequency of occurrence, abundance, and density of seagrass was computed as follows:

Frequency of occurrence = Number of occupied sub-units/total number of sub-units
Abundance = Sum of cover scale values/number of occupied quadrats
Density = Sum of cover scale values/total number of quadrats

2.1.2 Analysis and Interpretation of Seagrass Data

Distribution of the seagrass community was mapped for each transect from the diver identified edge of bed data, that was collected using a towed diver and communications equipment. Frequency of occurrence, abundance, and density were calculated from the quadrat data based on Braun-Blanquet (1965) methodology.

3.0 RESULTS

3.1 Seagrass Species Frequency of Occurrence, Abundance, and Density at Two Locations

Marine seagrass species observed within the study area included *Halophila decipiens*, no other seagrass species were found. No *Halophila johnsonii* was documented (Figure 3). In general, the *H. decipiens* bed was sparse to moderately dense, with density of seagrass decreasing from east to west. Data sheets are included as Appendix B.

At the two locations sampled, *H. decipiens* had a frequency of occurrence of 0.44 and 0.31 out of a possible 1.0 (Table 1).

Abundance and density values were the same in this case because the total number of quadrats sampled was the same as the total number of occupied quadrats sampled. Abundance and density for BB1 was 1.86 and 1.69 for BB2. Figure 4 and 5 show sample quadrats at BB2, a complete record of photos can be found in Appendix A.

3.2 Seagrass Bed Area Calculations

An estimated 1.03 acres of seagrass occurs between the nearshore hardbottom and middle reef. An estimated 0.20 acre of this area lies within the project footprint and may be impacted by the planned deepening and widening of Port Everglades.

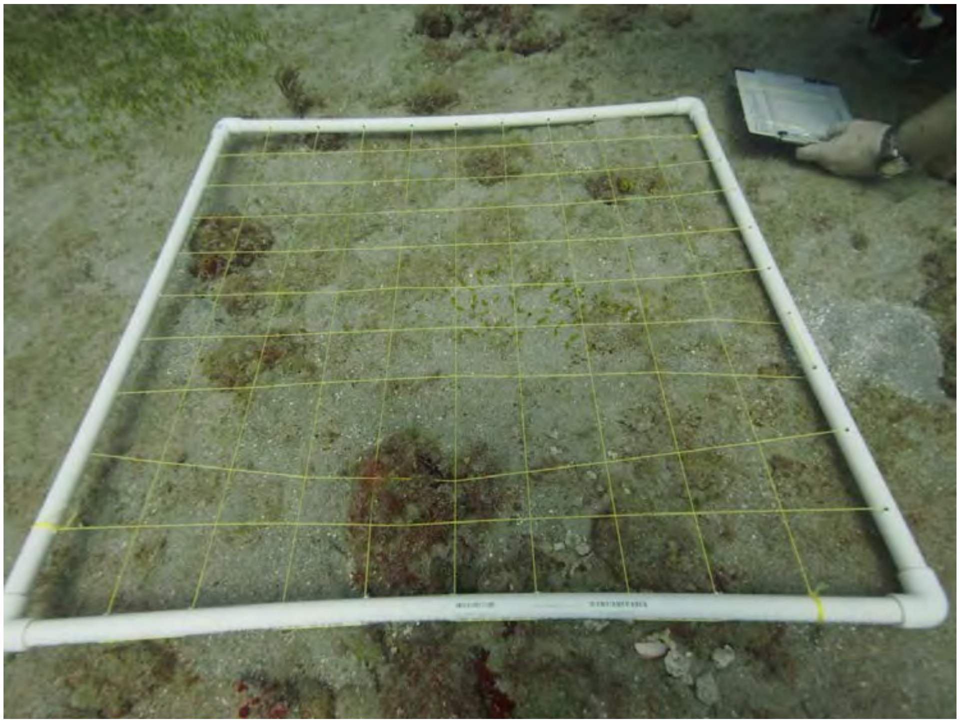


Figure 4 Sparse *Halophila decipiens* within 1m^2 quadrat at BB2.

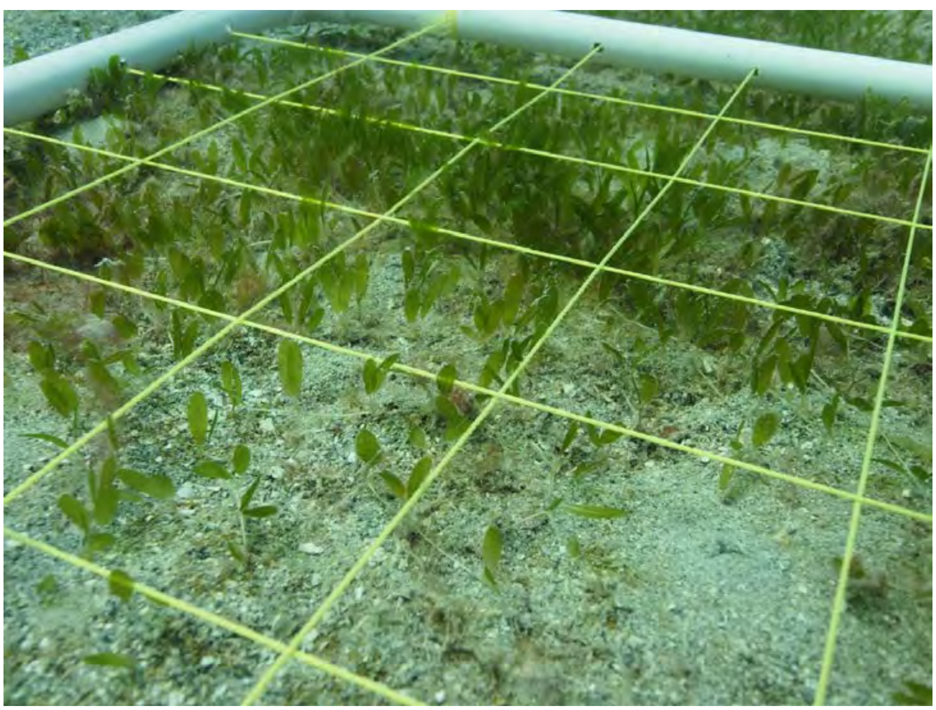


Figure 5 *Halophila decipiens* within a sample quadrat at BB2.

3.3 Seagrass Bed West of Nearshore Hardbottom

An *H. decipiens* seagrass bed persists west of the seagrass bed between the nearshore hardbottom and middle reef along Transect 10 (Figure 3). *H. decipiens* was sparse here and due to diver safety, no quadrat data were collected in this location. This seagrass bed is outside of the proposed project footprint.

Table 1 *Halophila decipiens* Frequency of Occurrence, Abundance, and Density Values between nearshore and middle reef.

	Frequency	Abundance	Density
BB 1	0.44	1.86	1.86
BB 2	0.31	1.69	1.69

4.0 DISCUSSION

Seagrasses in the vicinity of Port Everglades have been documented since the late 1990s (DC&A 2009). Most seagrass in the vicinity are located in shallow water (1-20 feet), within the AIWW and Dania Cutoff Canal (DCC) as well as in the turning basin and inner entrance channel. This survey conducted in August 2013 documented a 1.03 acre *H. decipiens* bed between the nearshore hardbottom and middle reef on the south side of the outer entrance channel in 35-40 feet of water.

H. decipiens is known to occur in offshore waters of south Florida as deep as 50 feet (Williams 1988). *H. decipiens* beds within the outer entrance channel and adjacent to the outer entrance channel have been documented in the past by Dial Cordy and Associates and Broward County (DC&A 2009; Personal Communication January 18, 2001, Steve Higgins, Beach Erosion Administrator Broward County). The occurrence of this seagrass bed is not unusual considering the natural distribution of the species and the history of seagrasses within the area.

The 1.03 acres of *H. decipiens* documented during the August 2013 survey includes 0.20 acre of seagrass that may be impacted by the deepening and widening project. Seagrass mitigation may be required for this acreage.

5.0 REFERENCES

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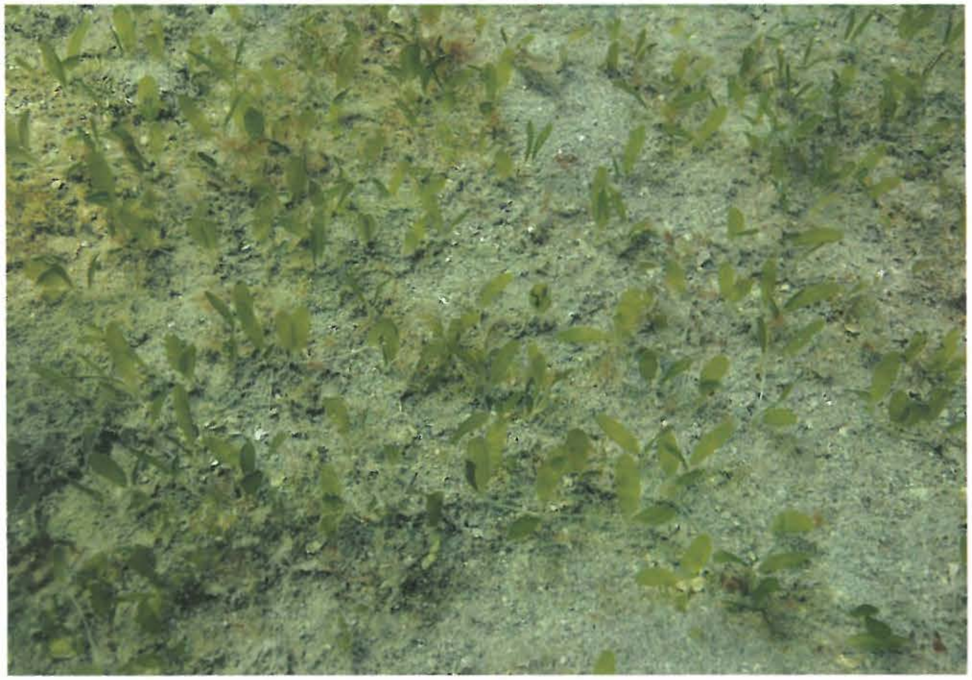
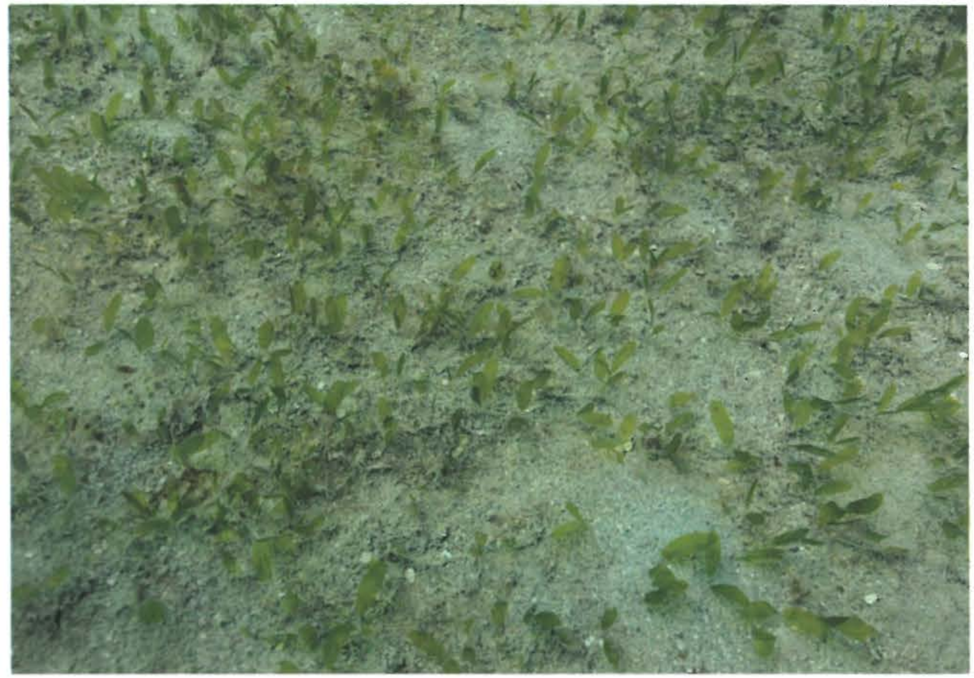
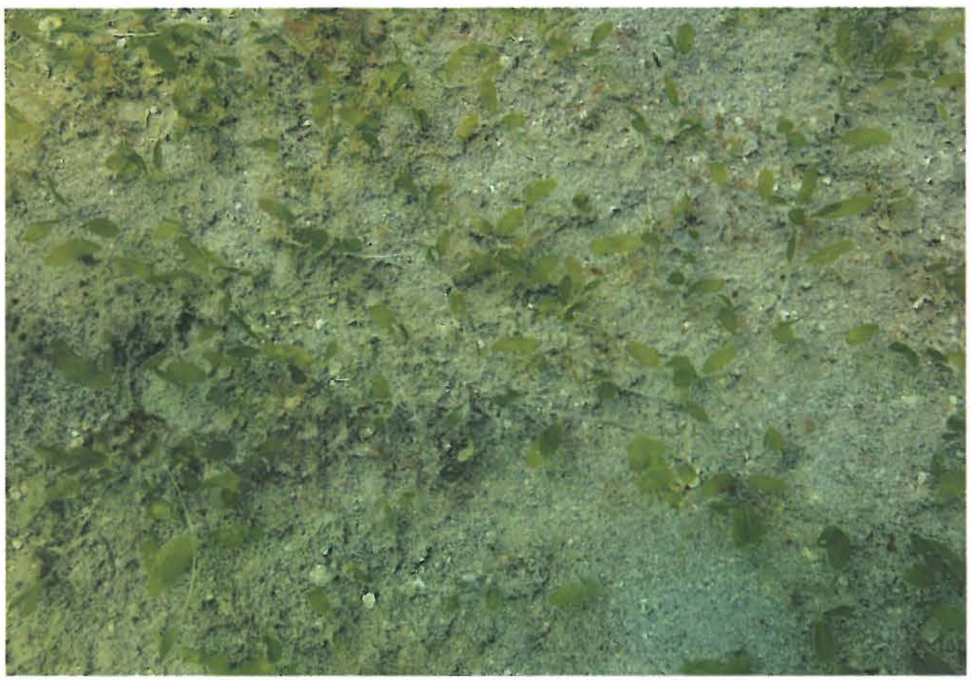
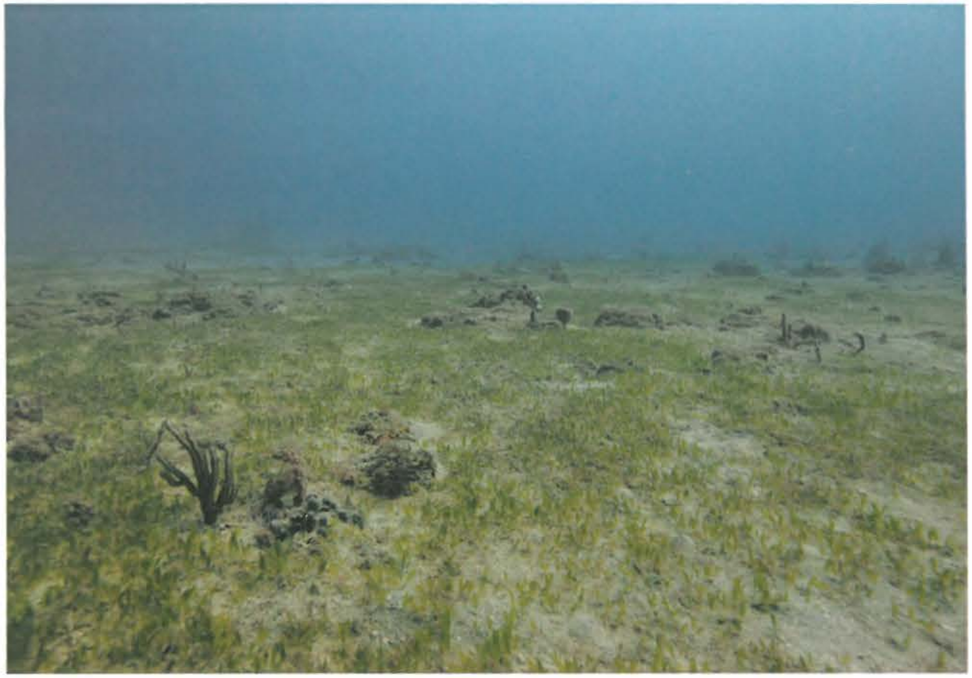
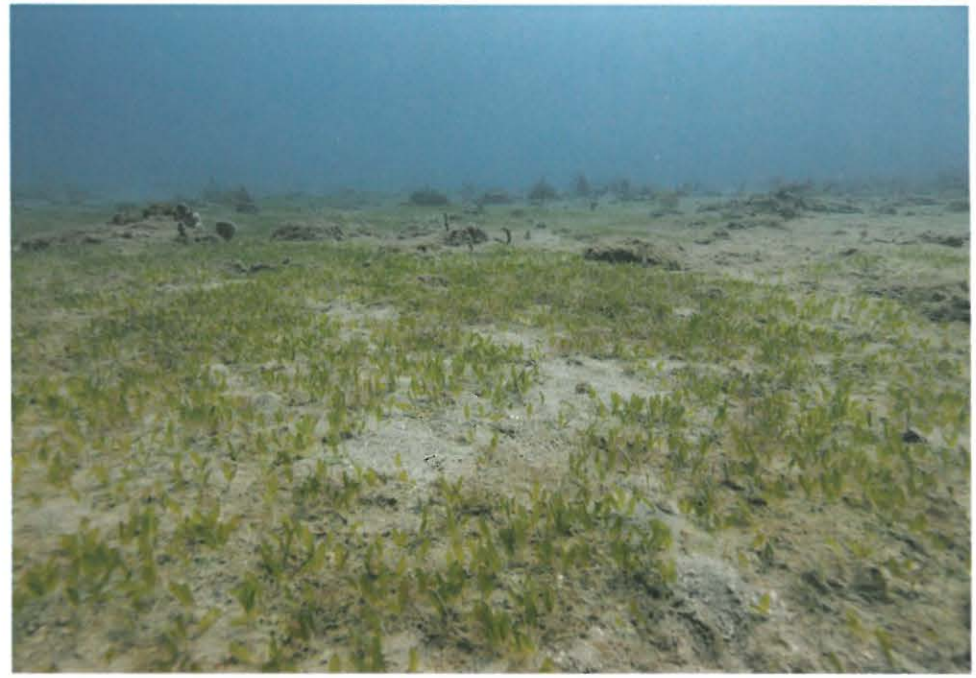
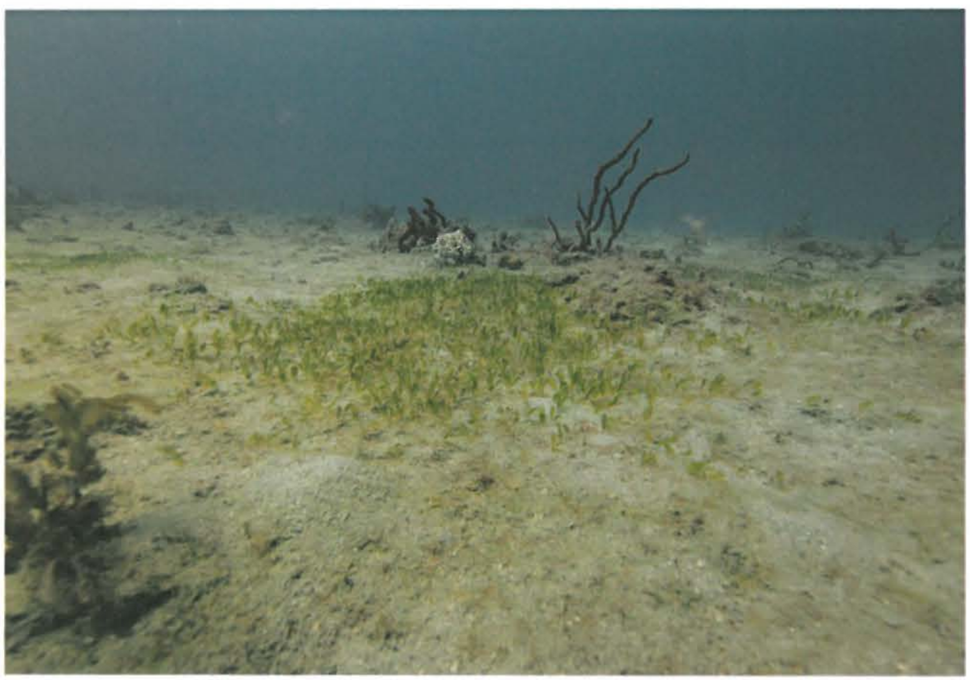
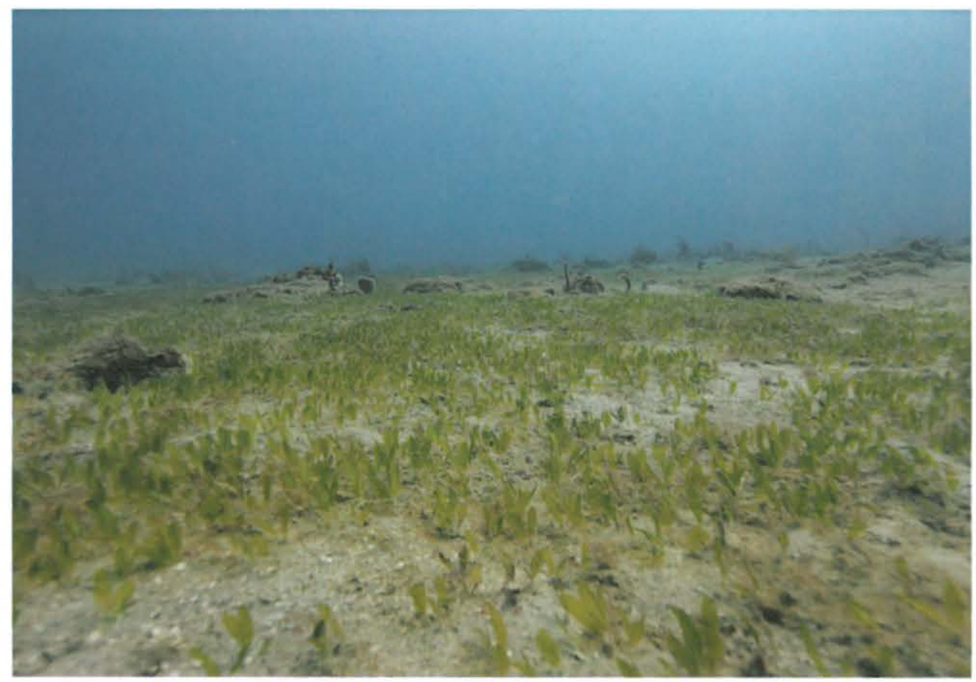
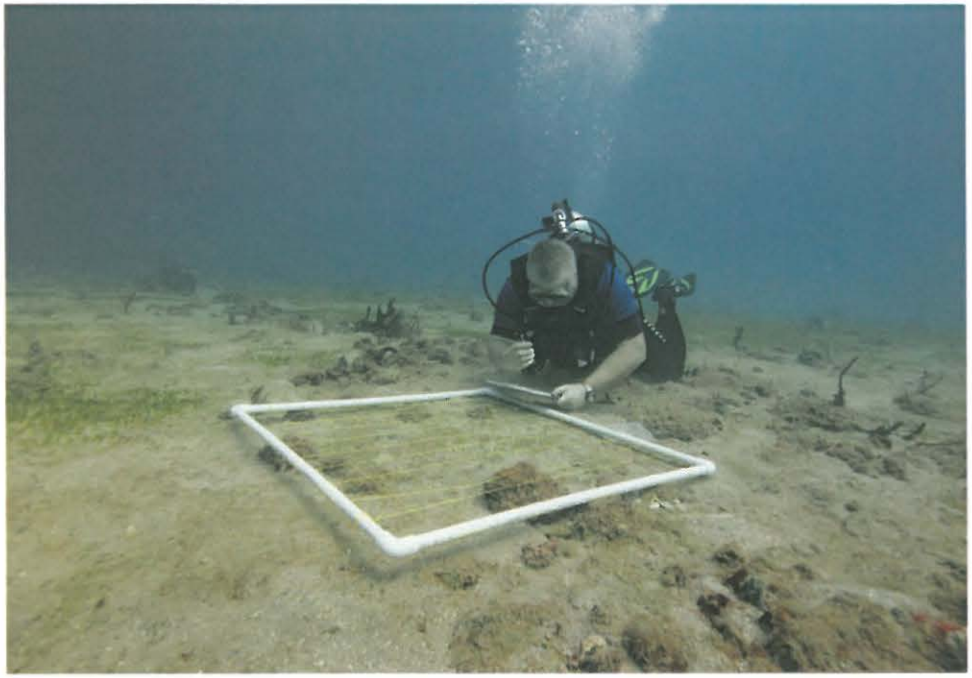
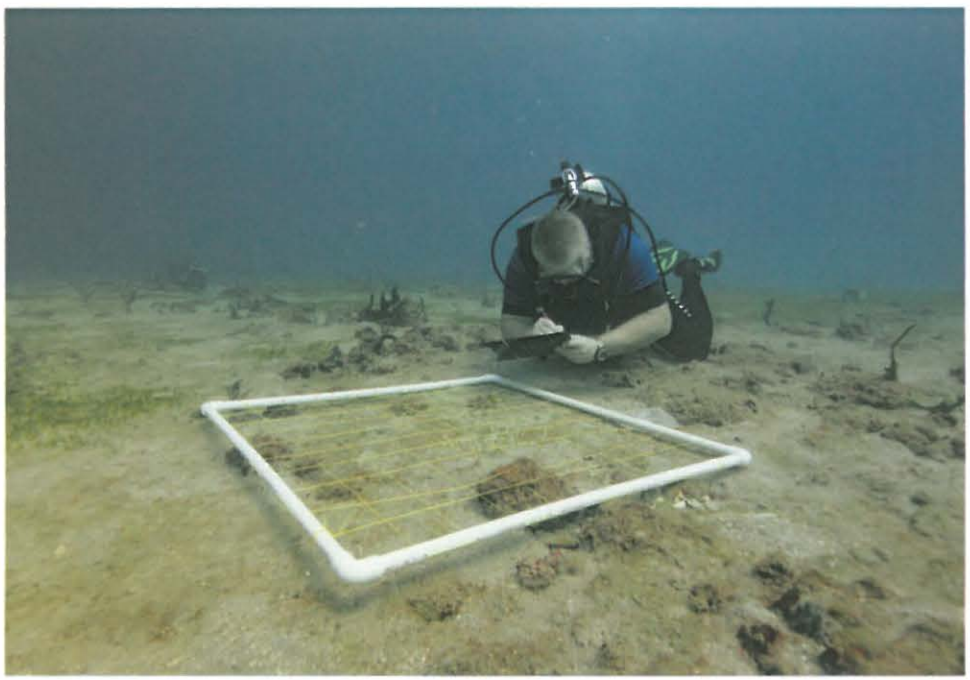
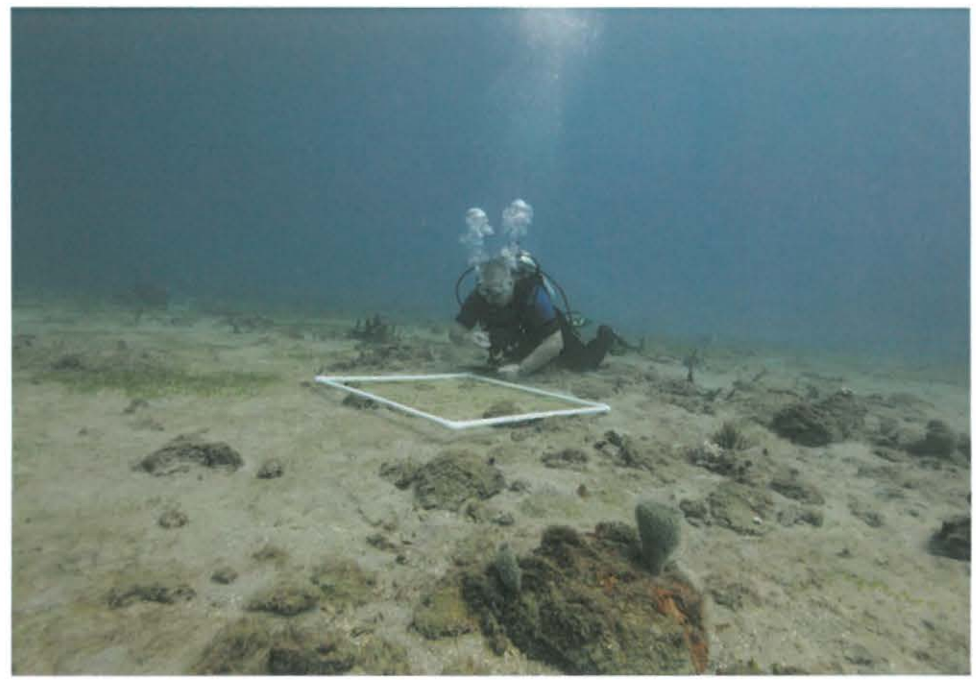
APPENDIX A

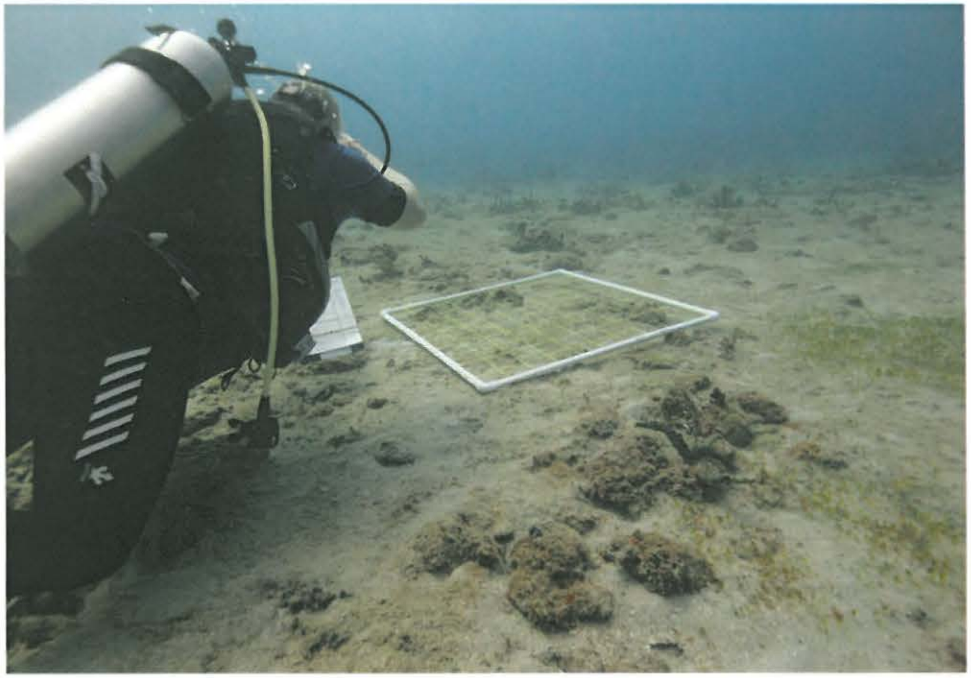
Photographs

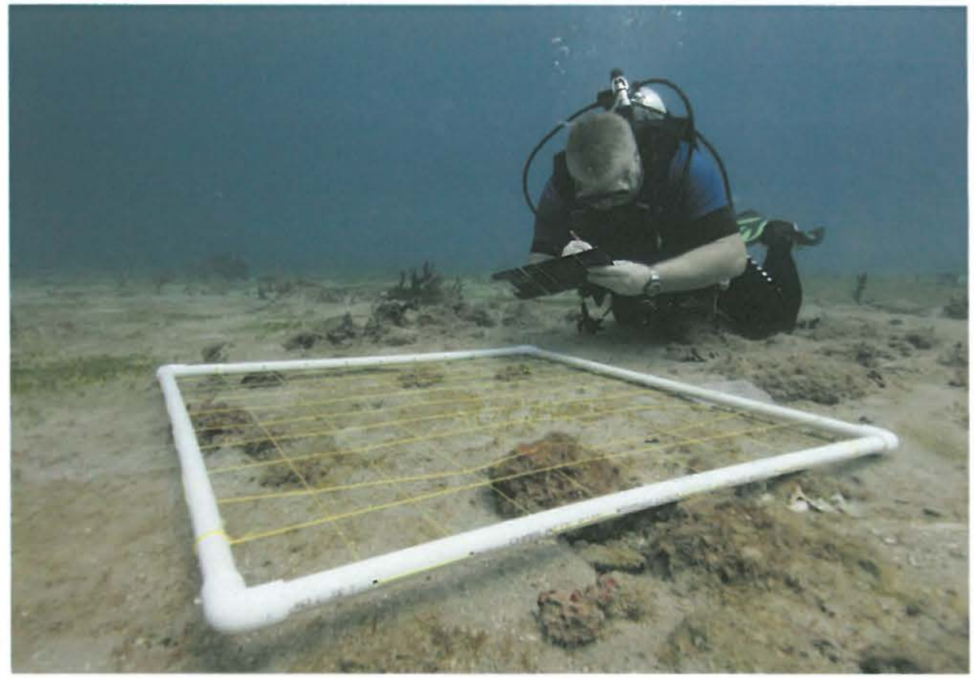




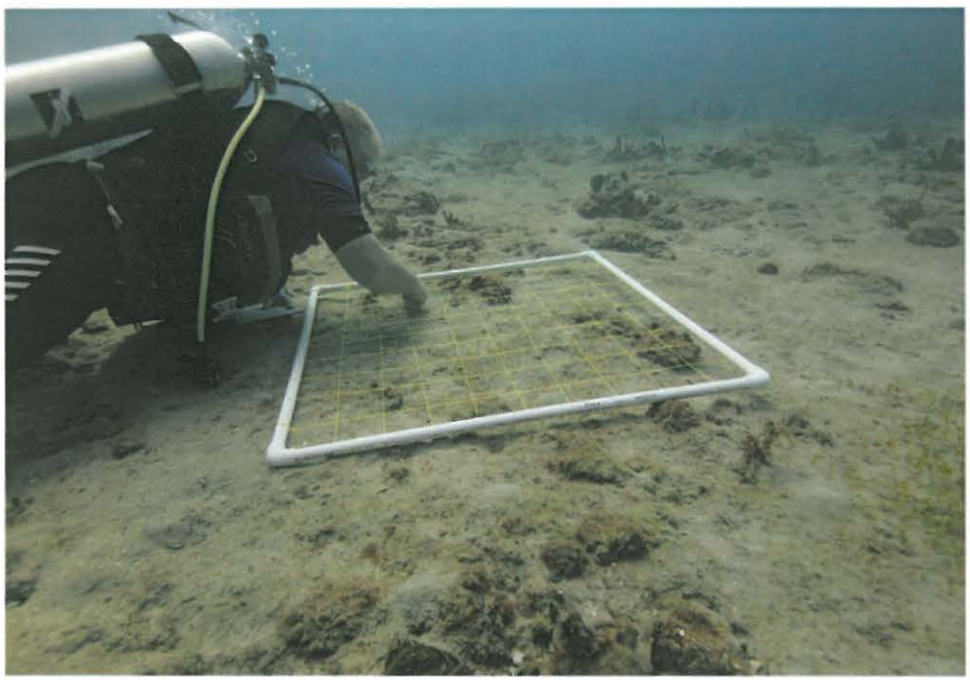






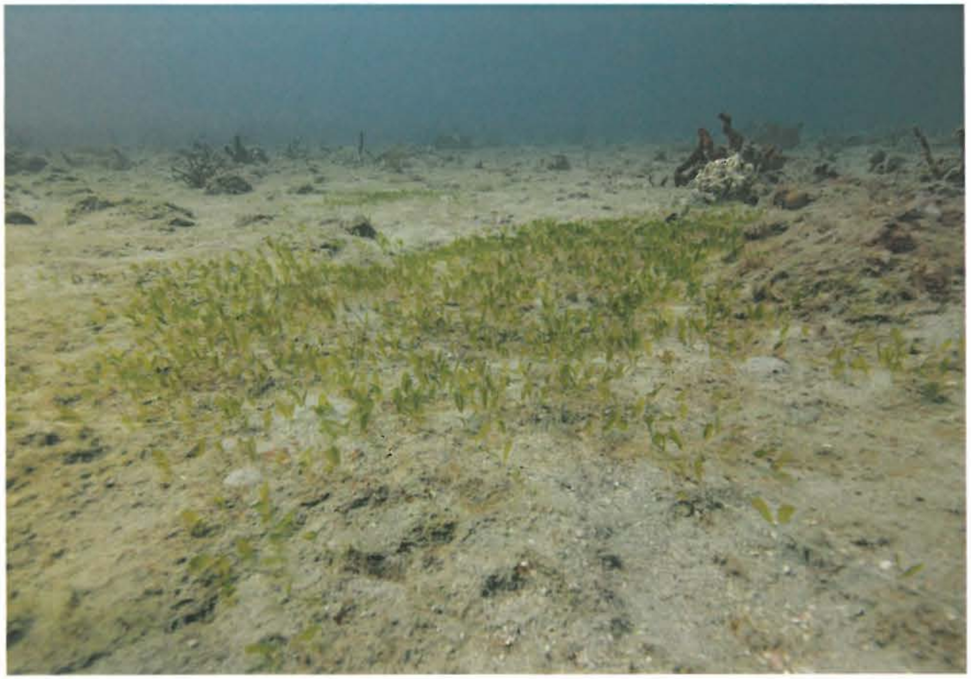
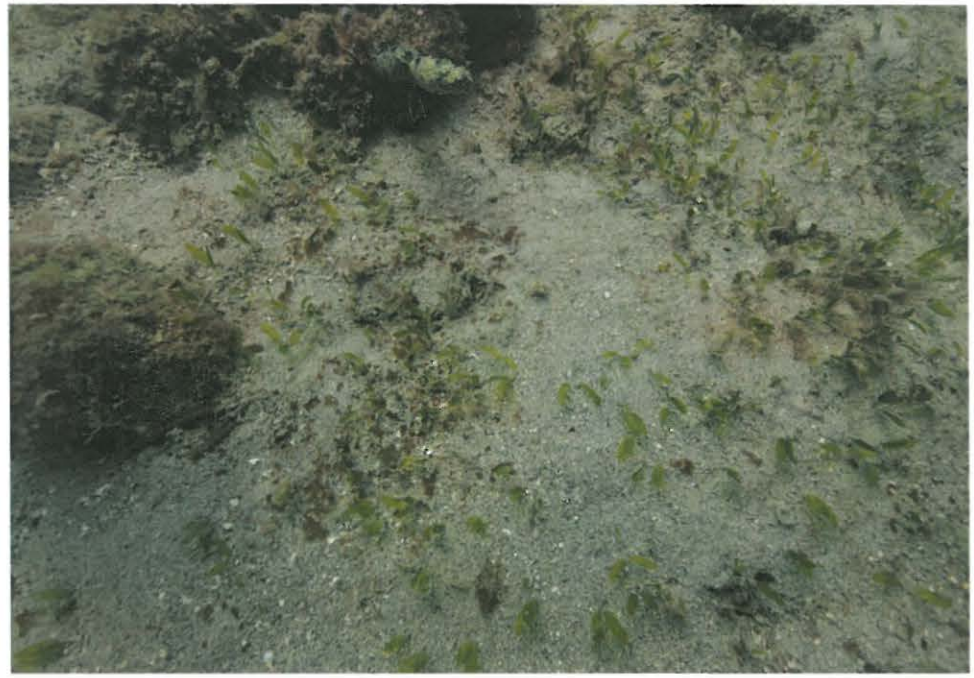
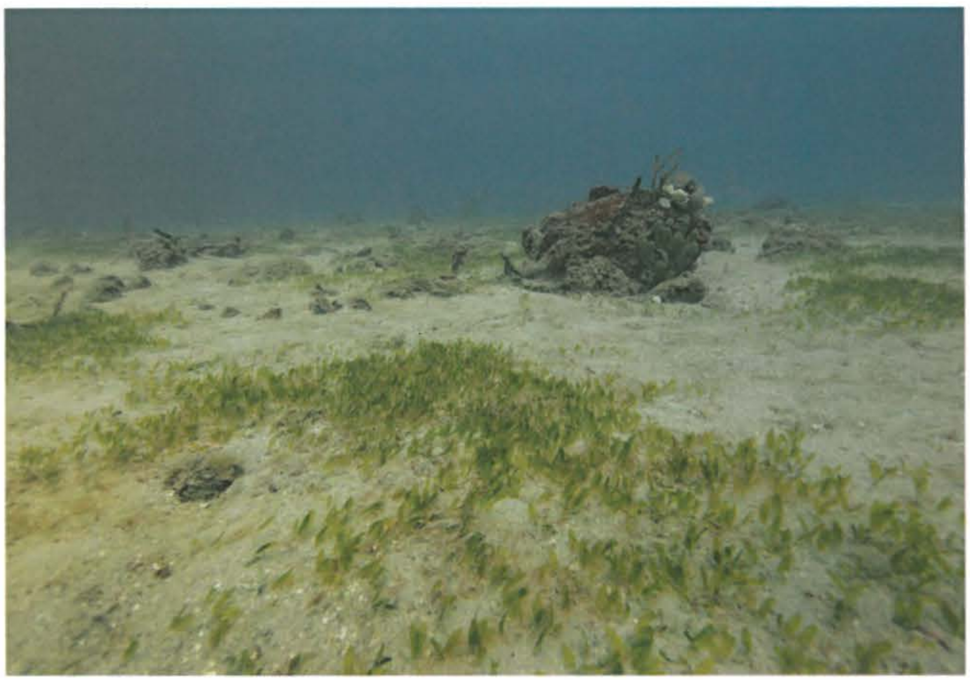
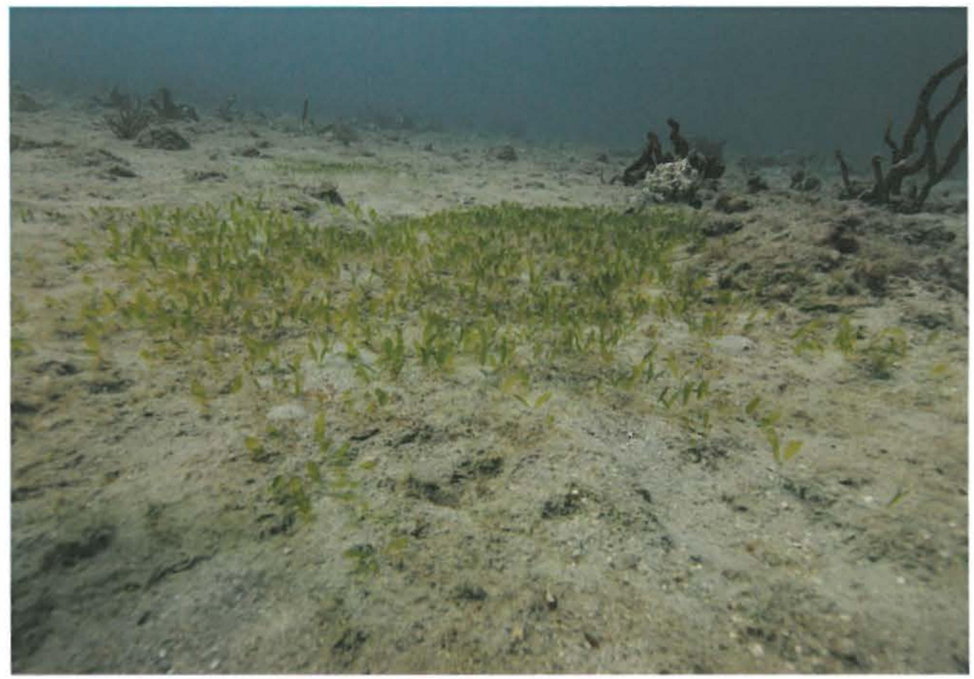


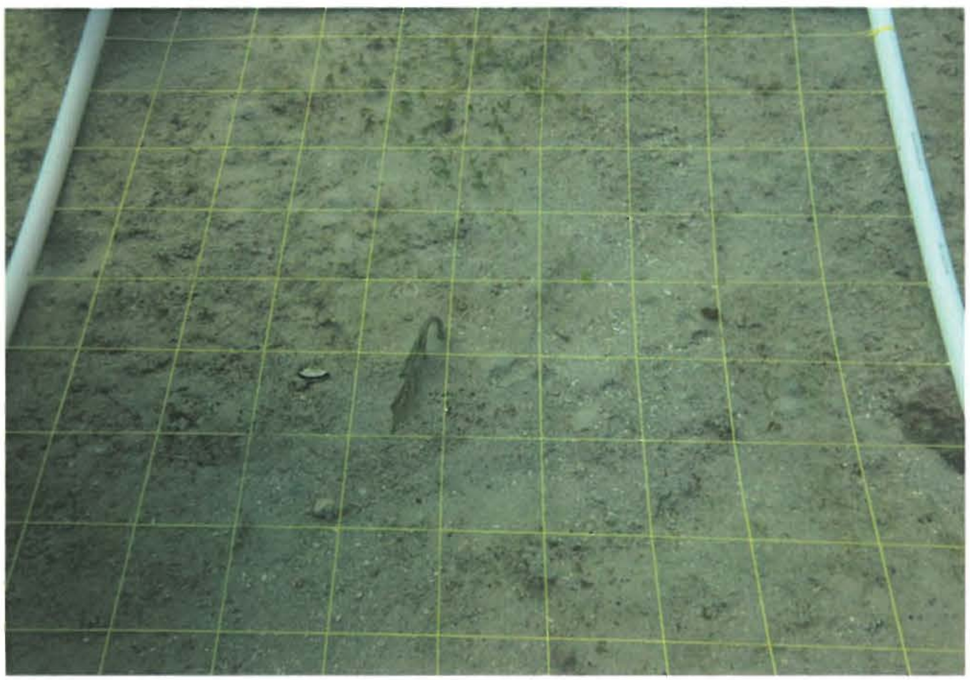


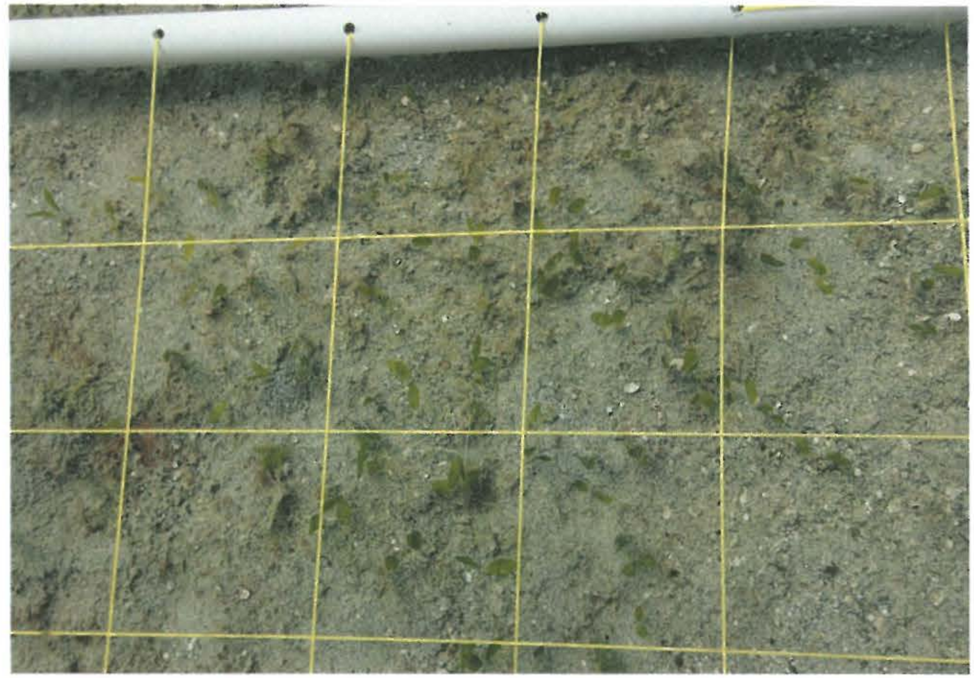


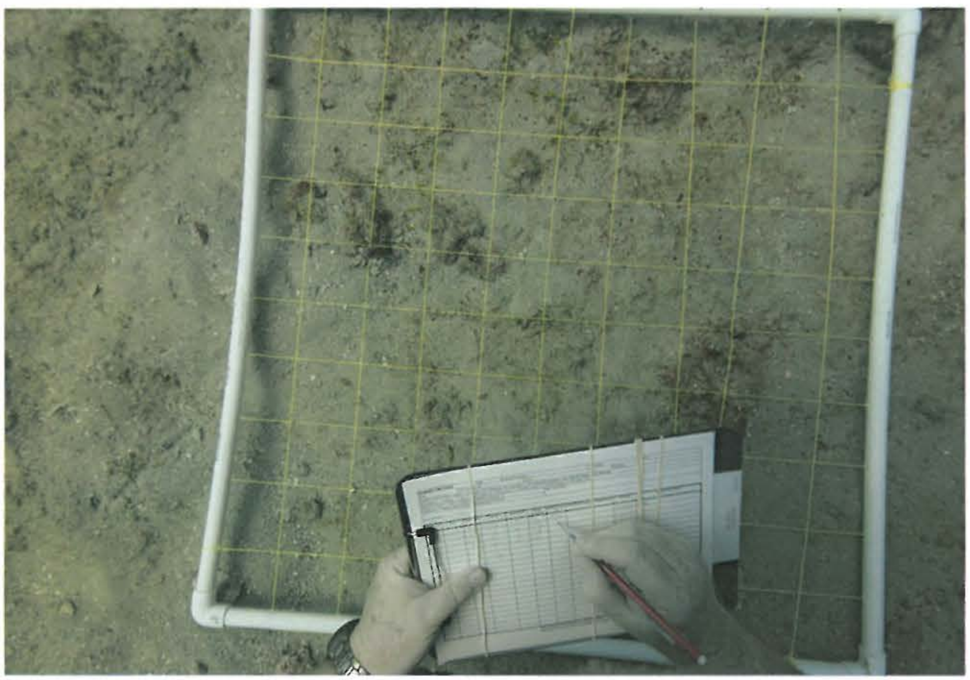


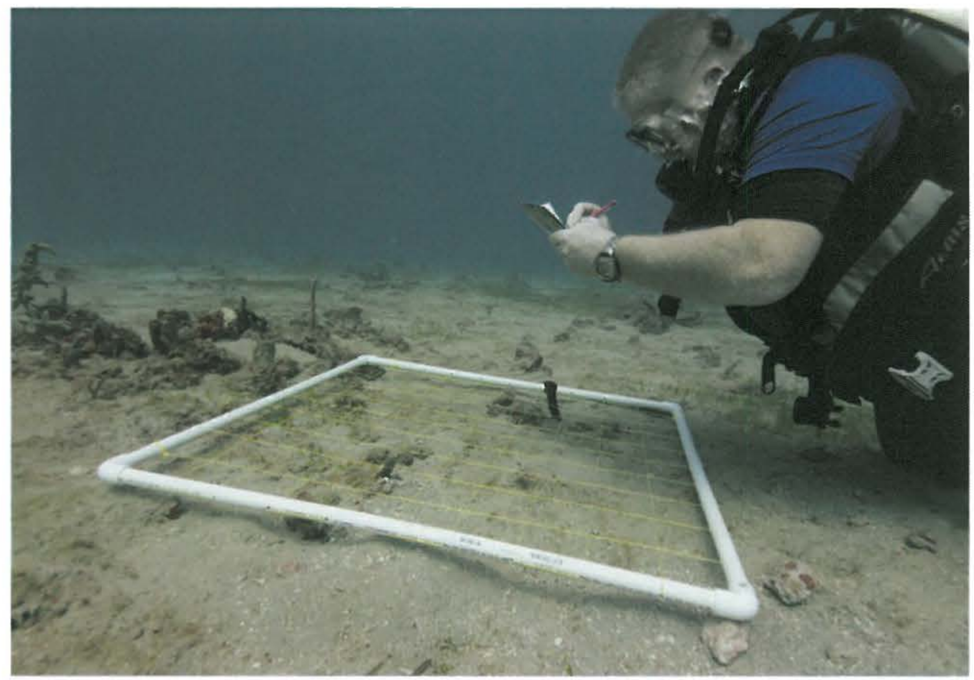





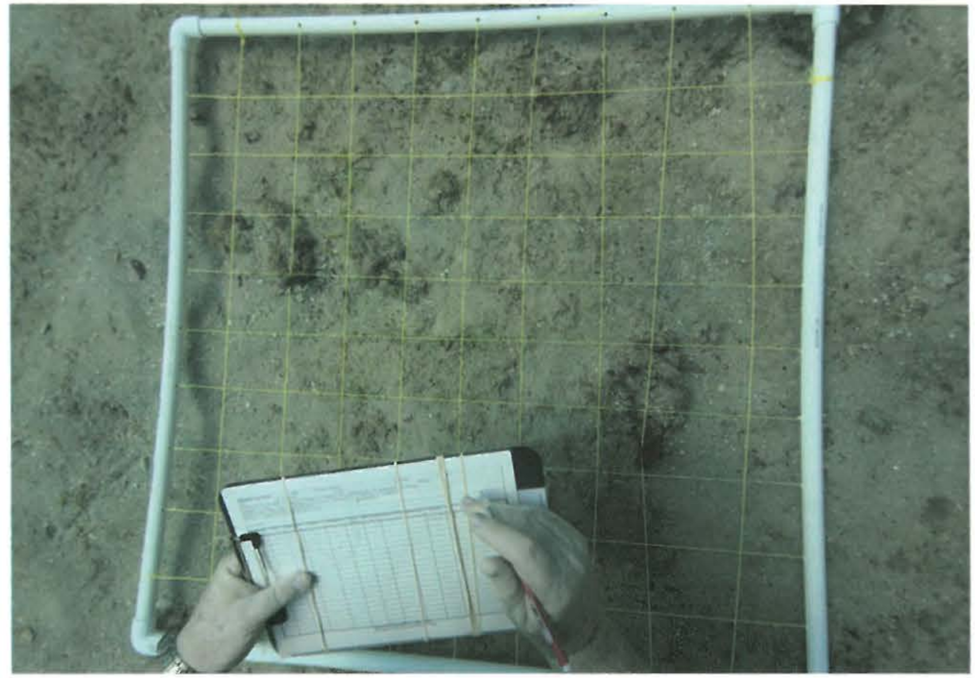
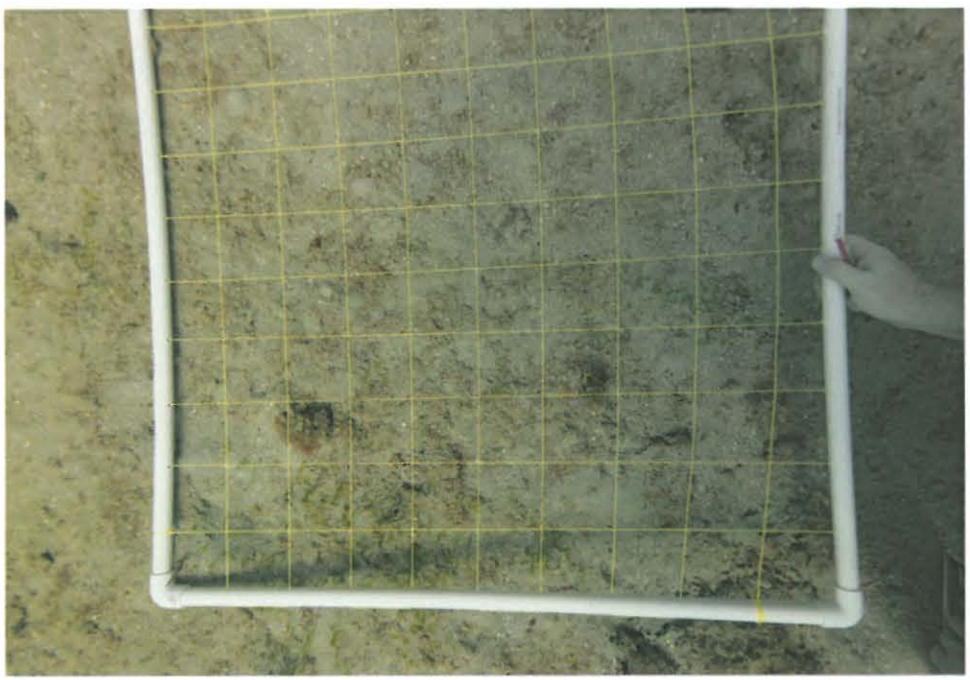
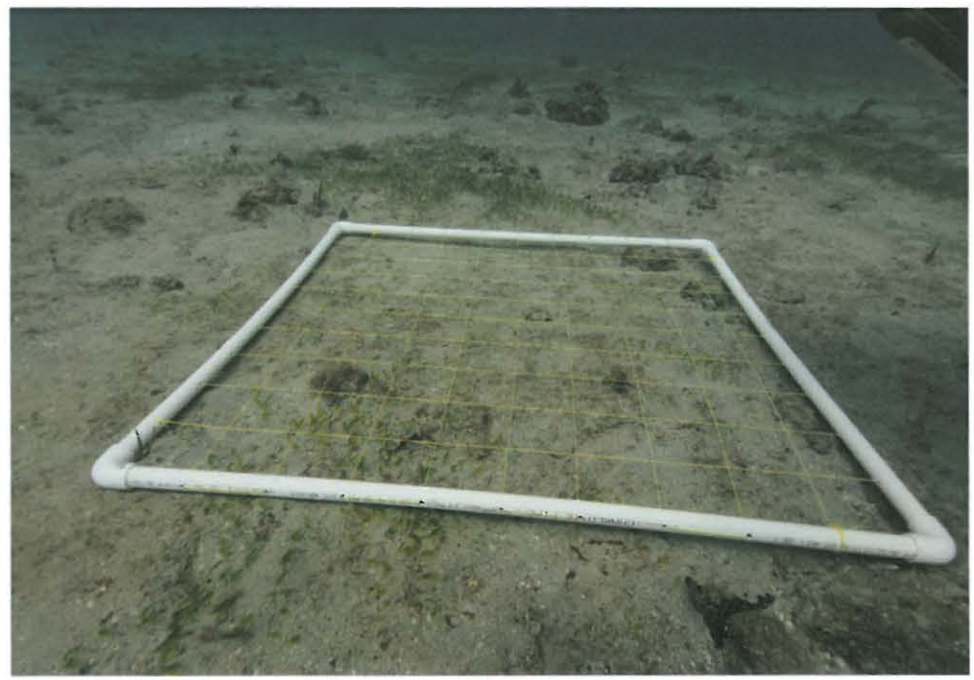


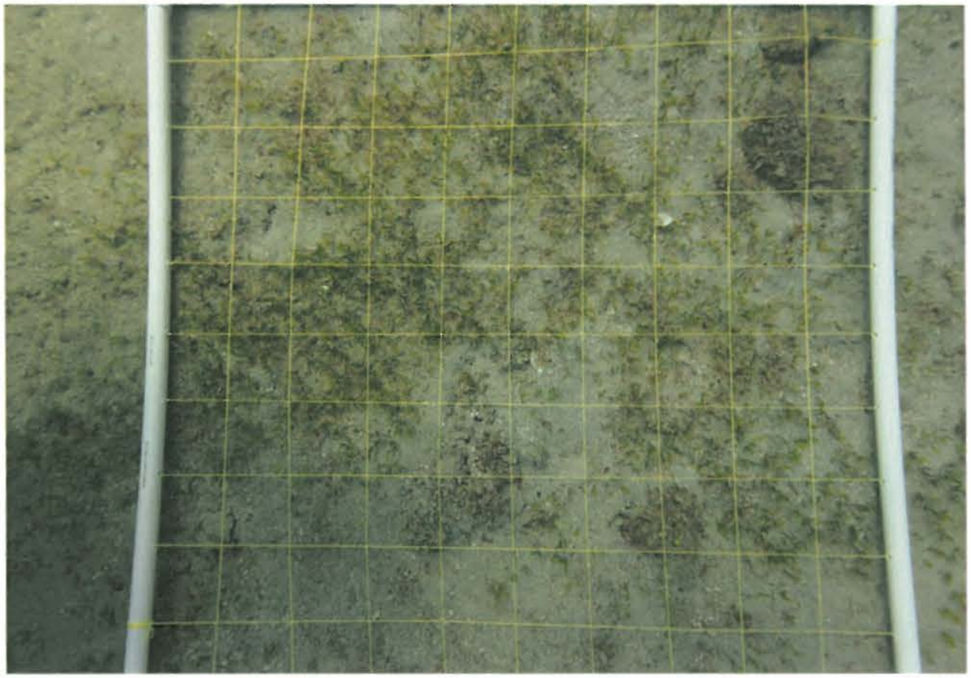
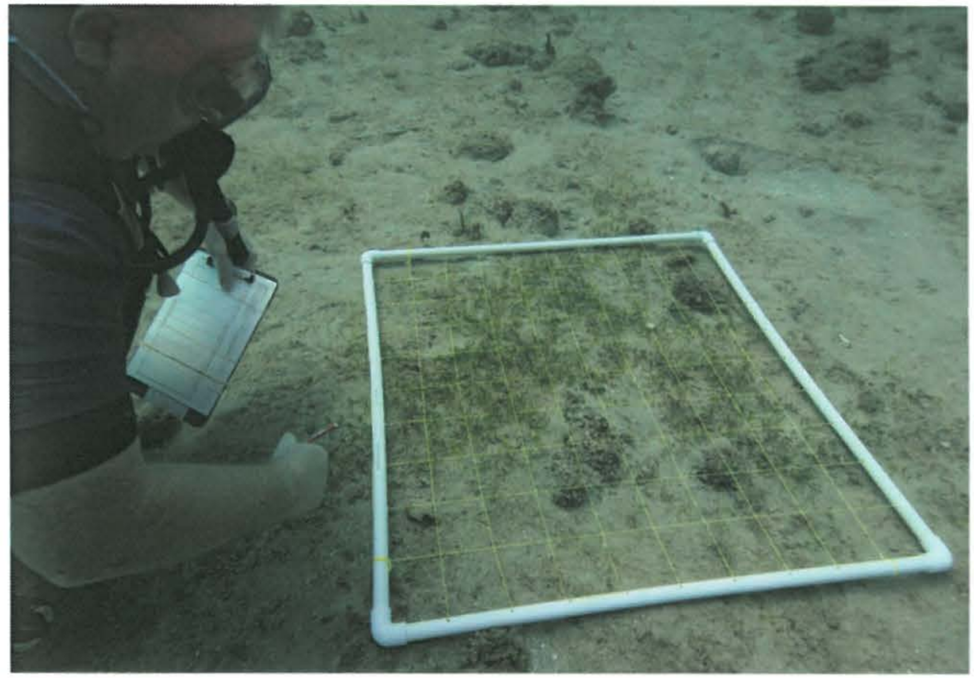
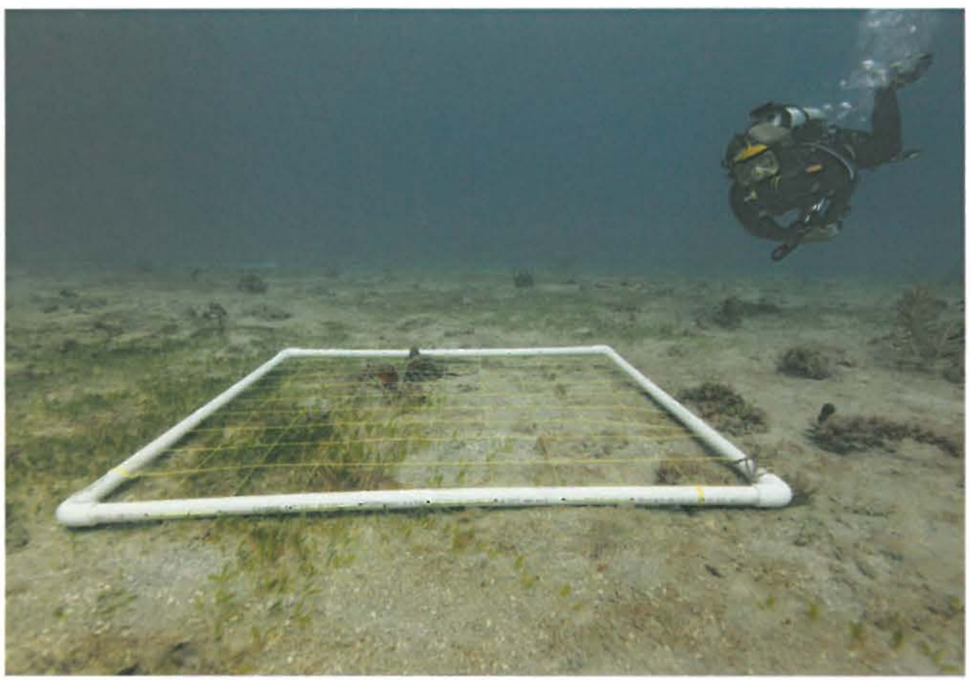
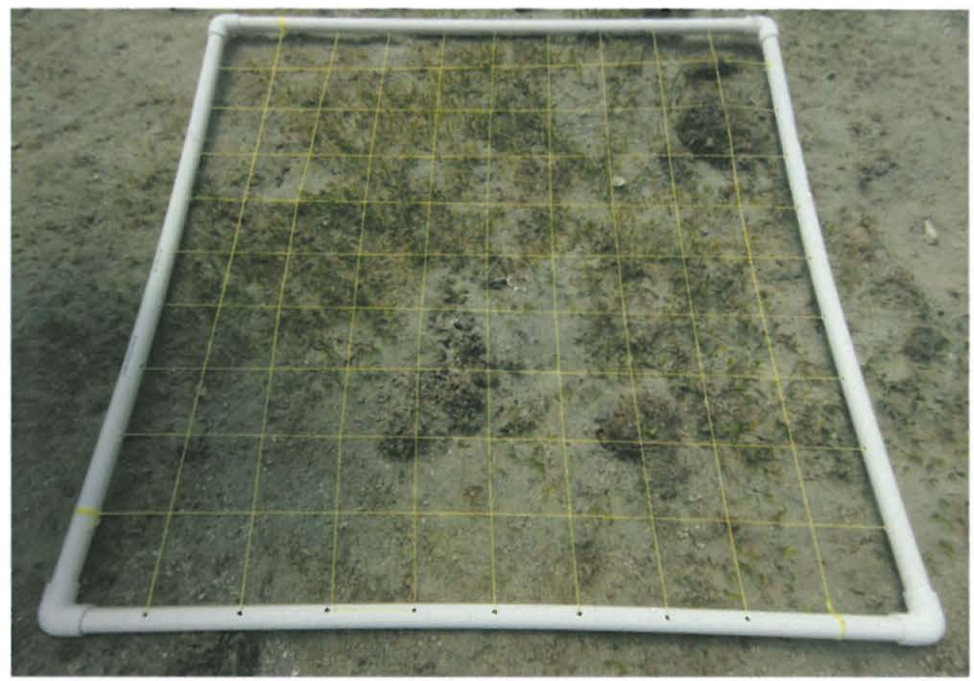


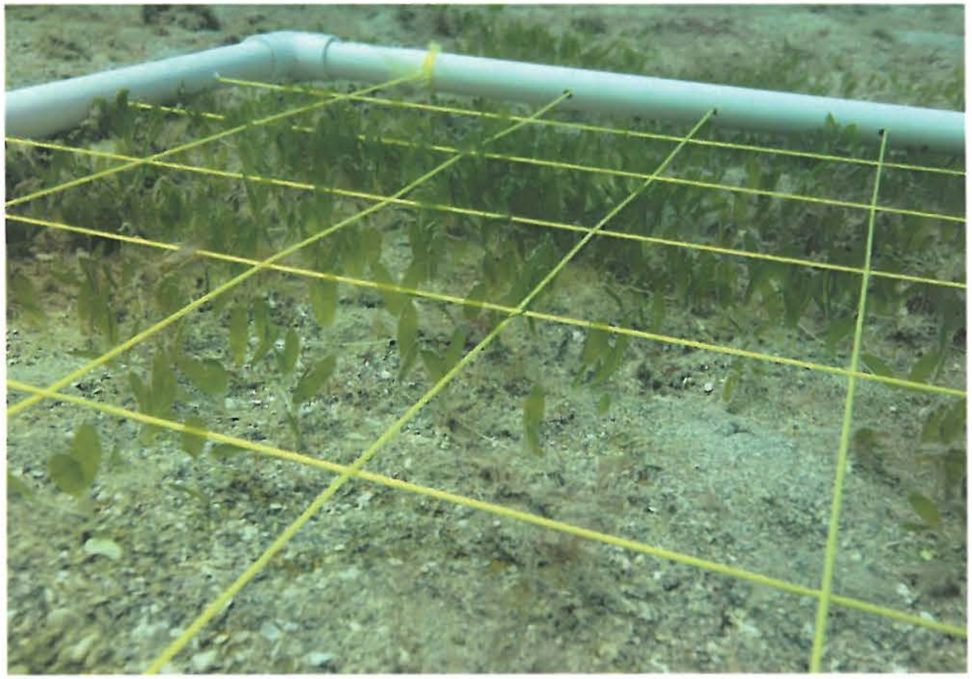
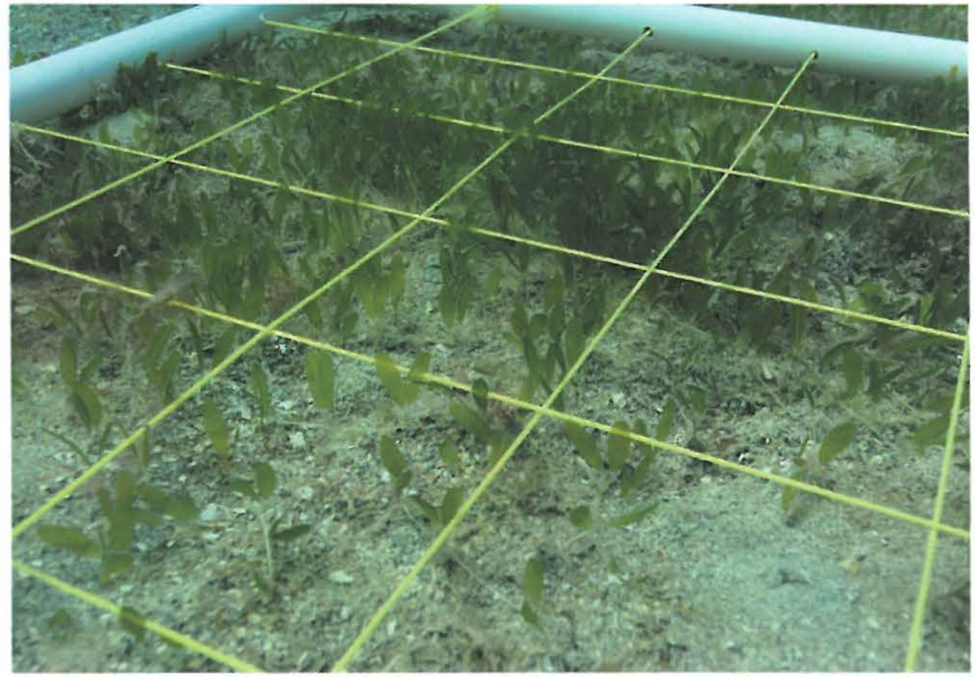
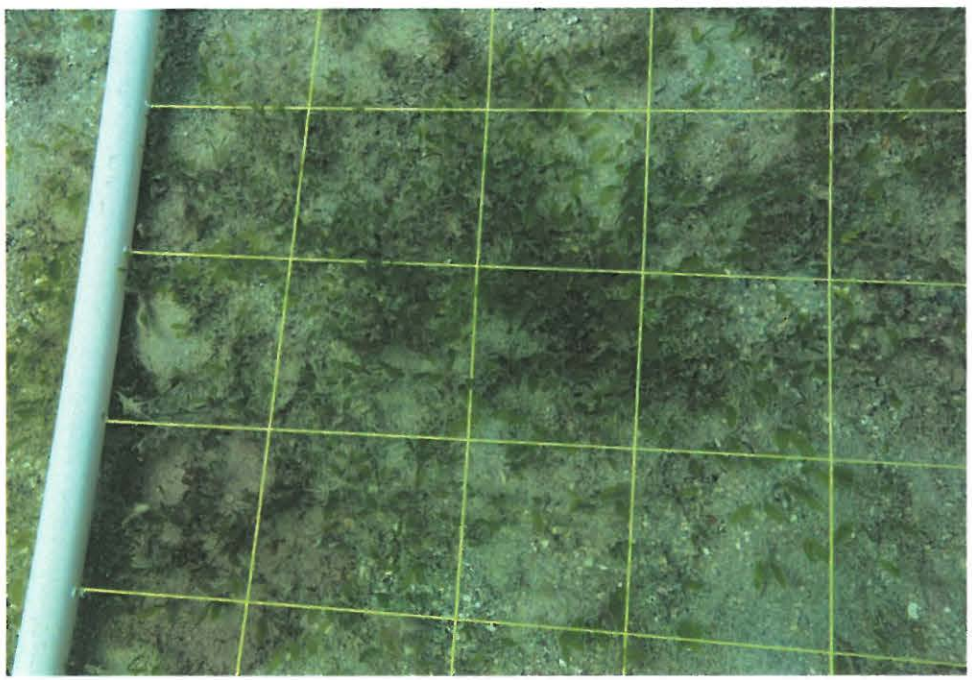
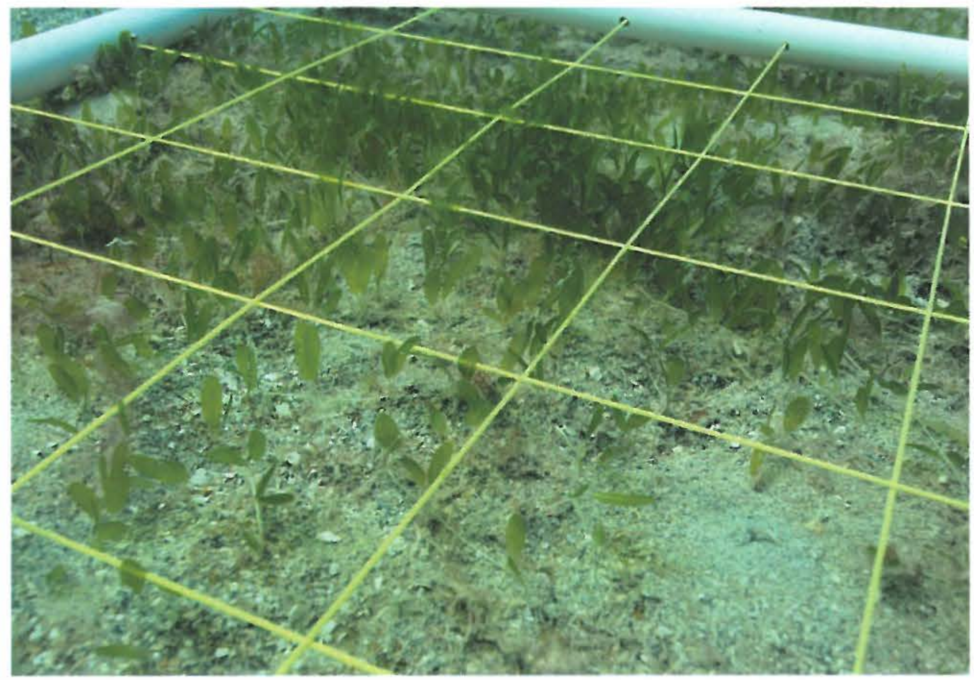


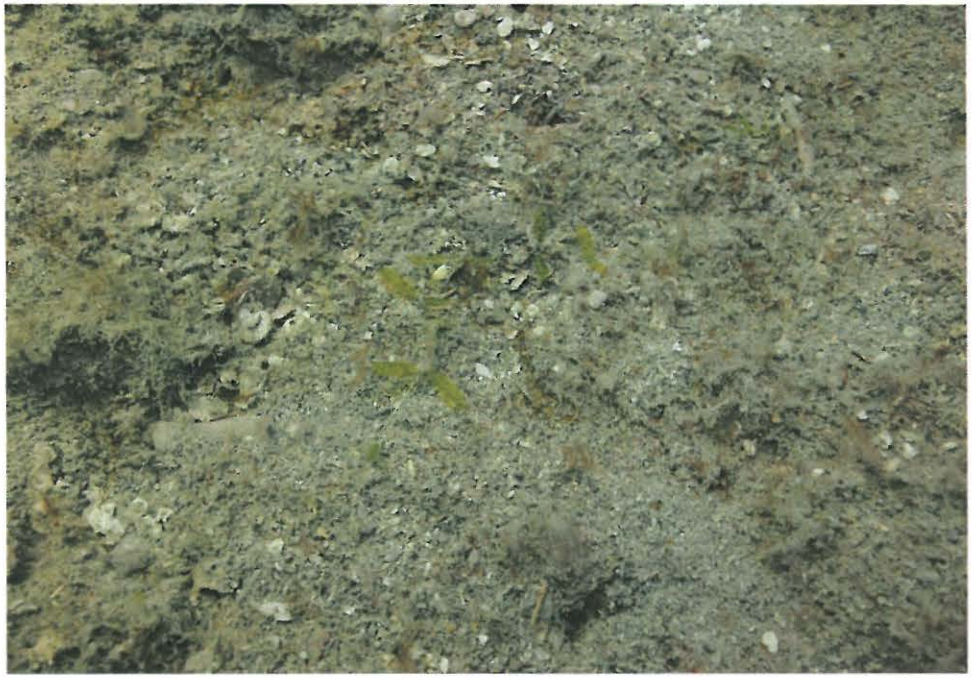
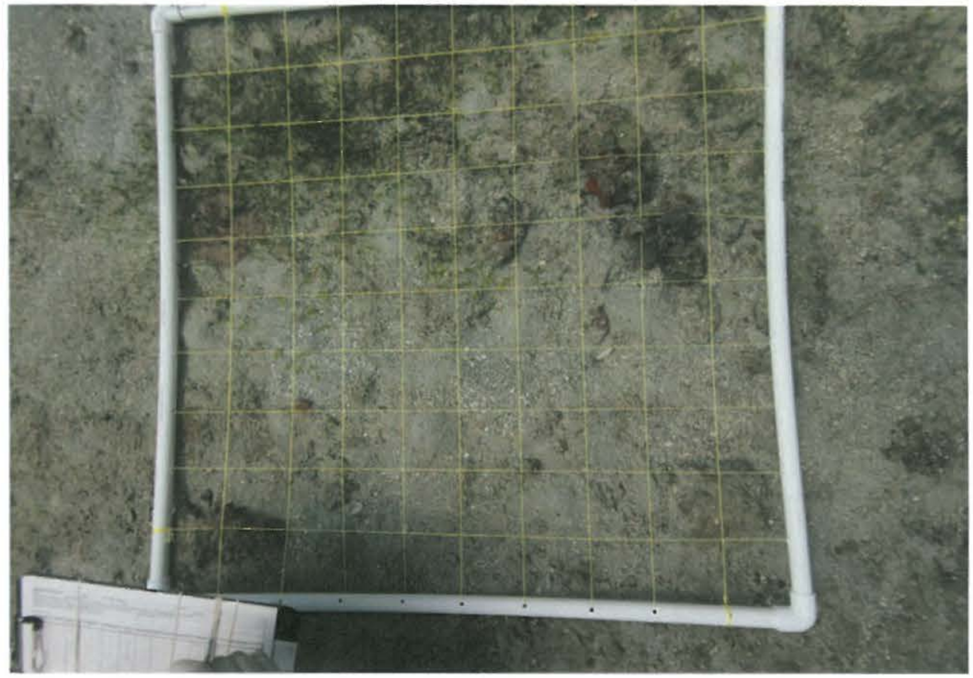
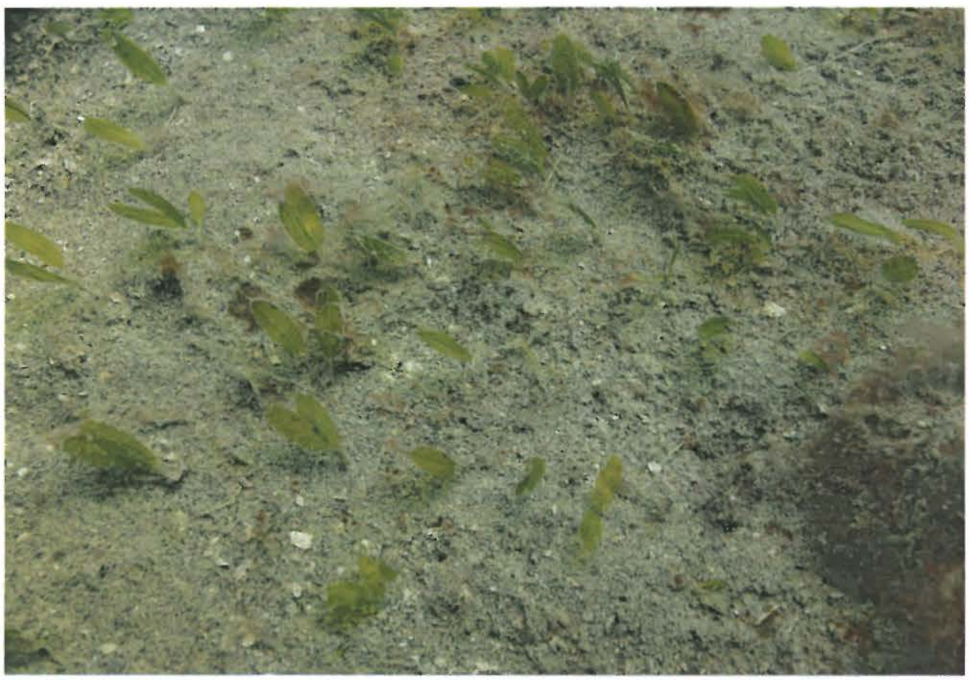
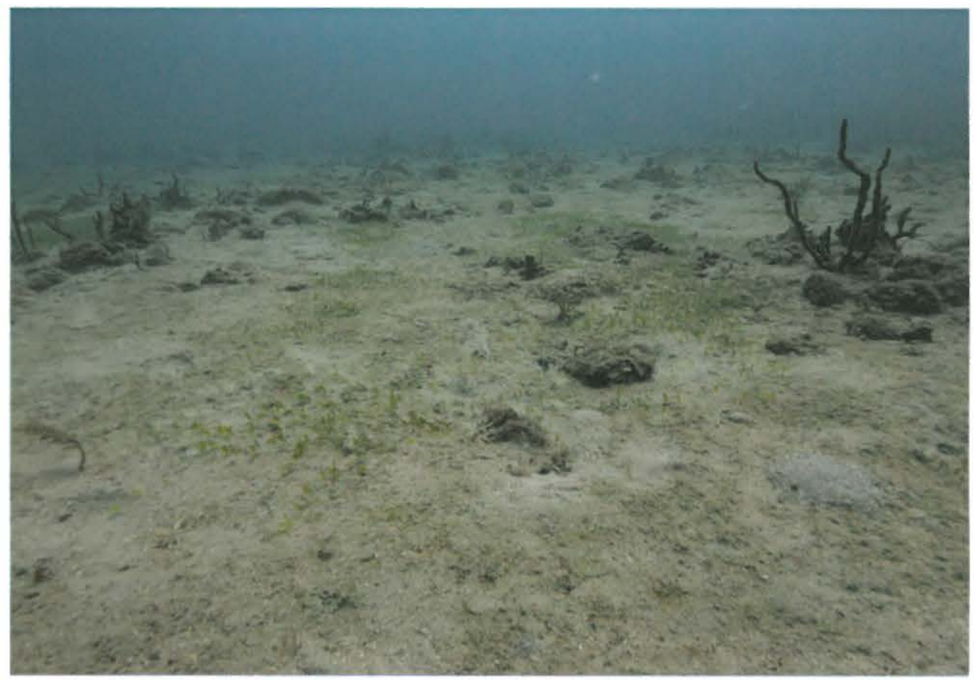


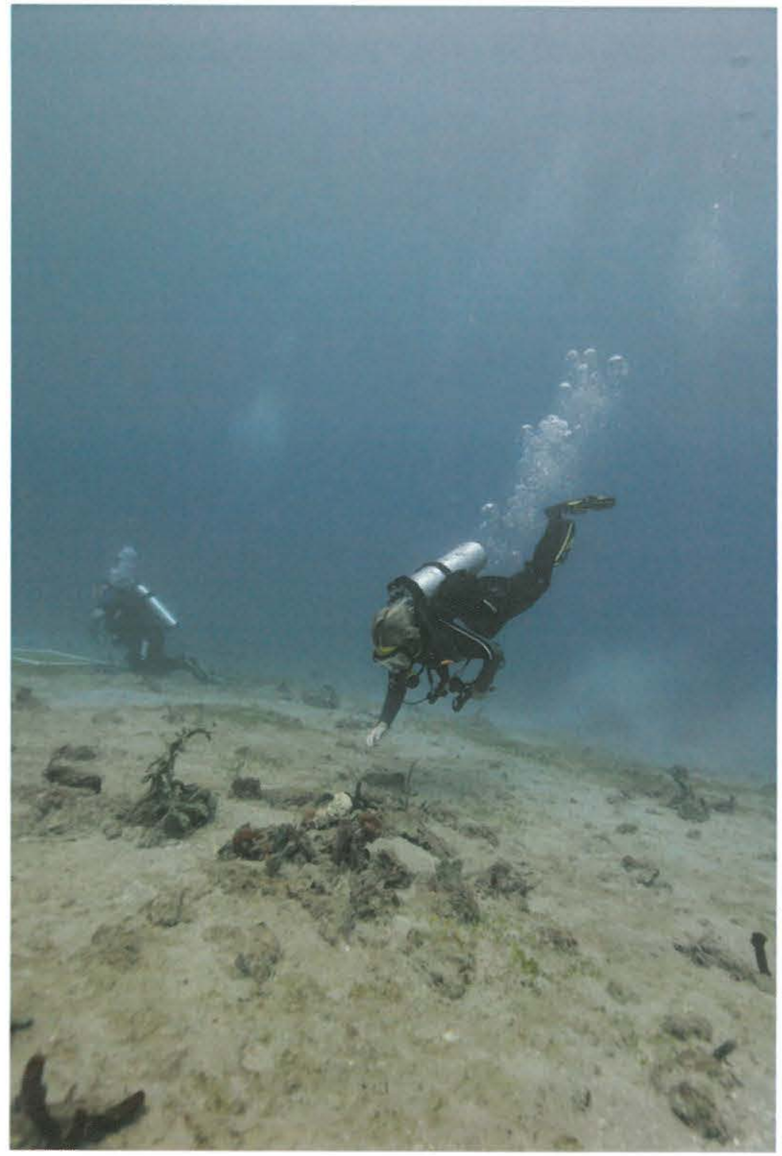





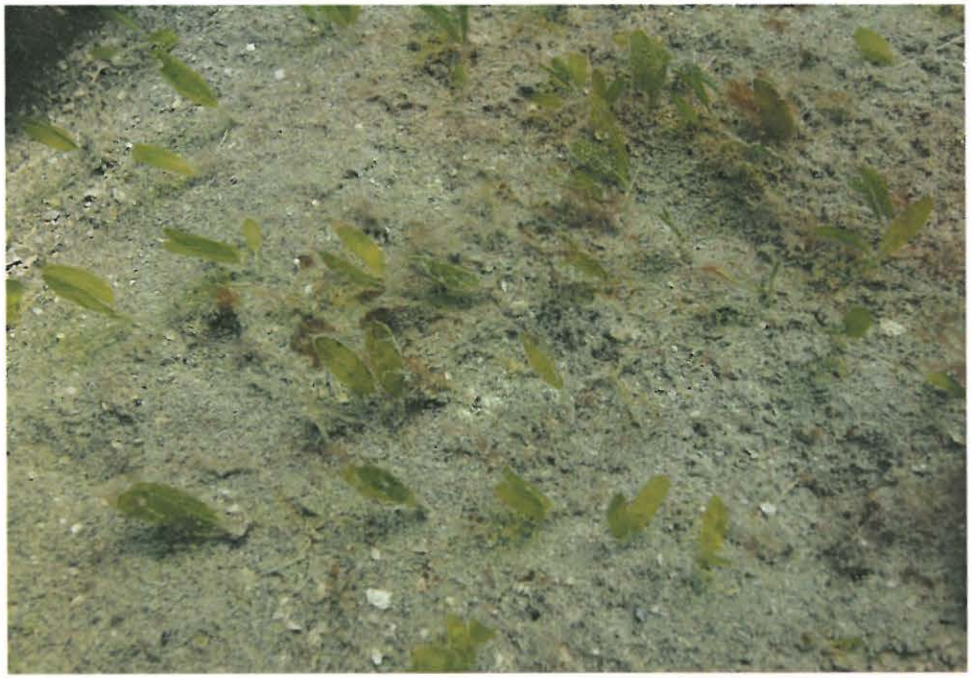
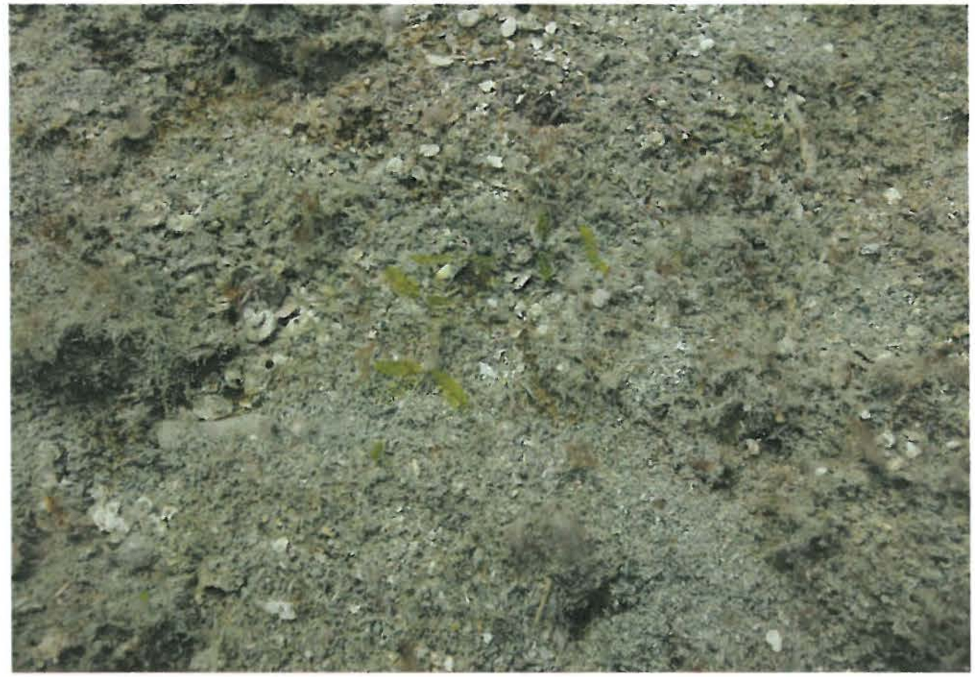





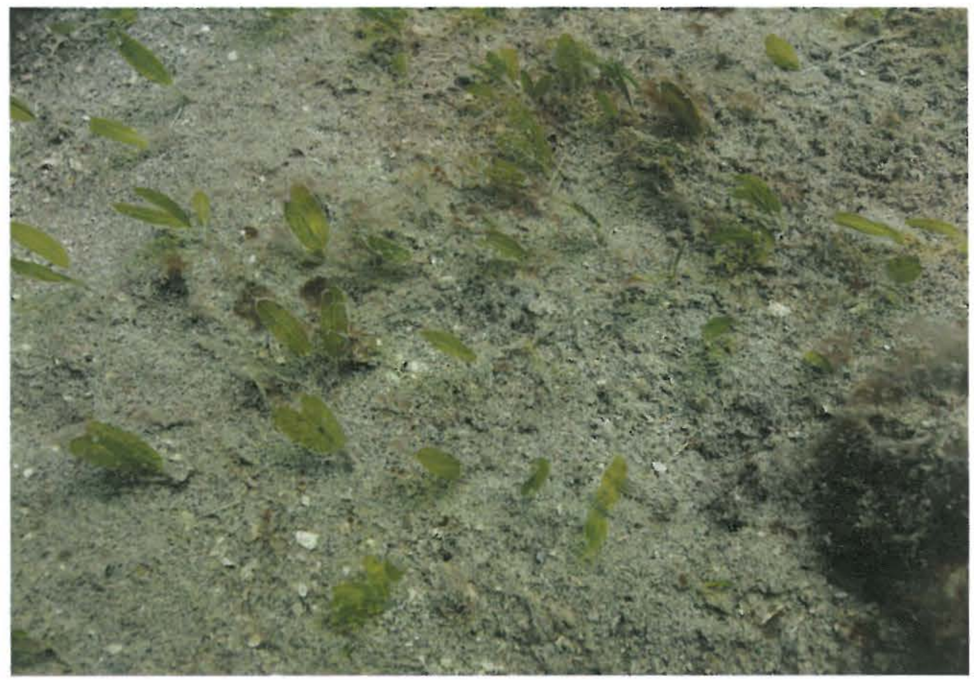


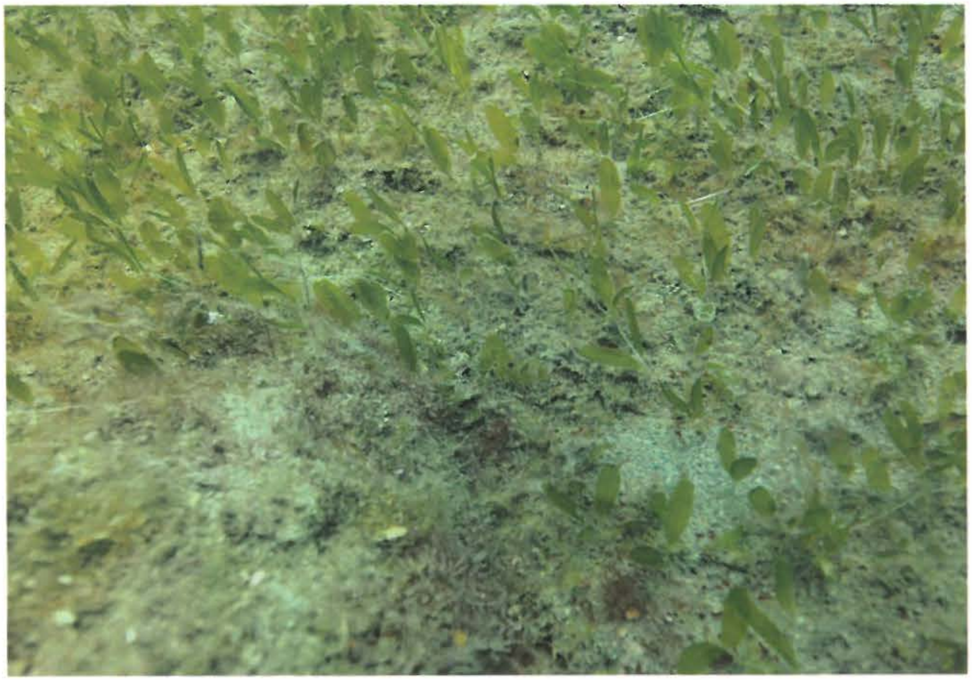
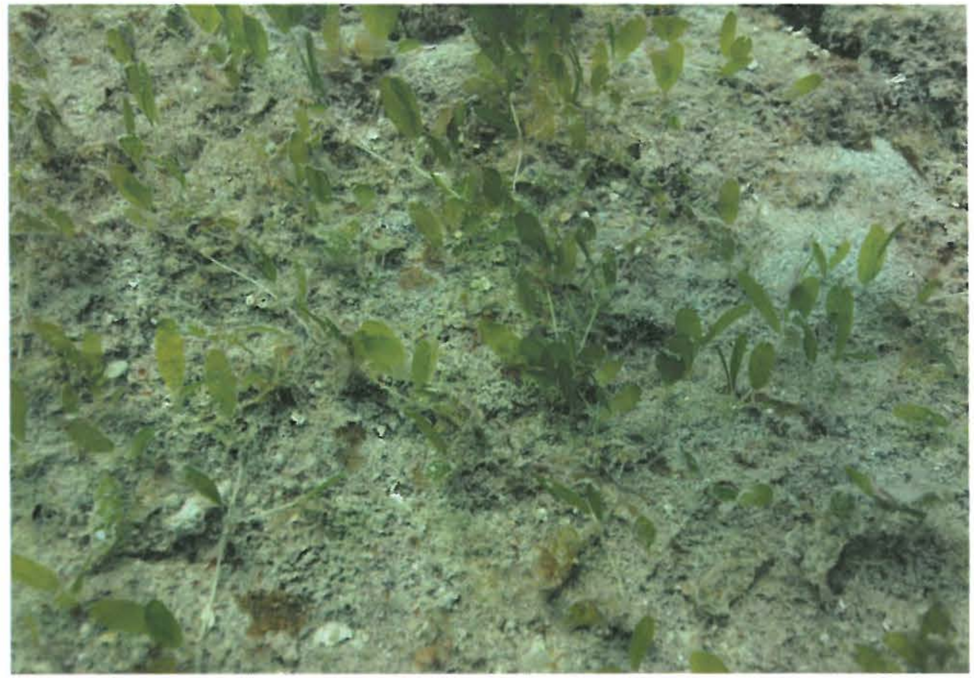






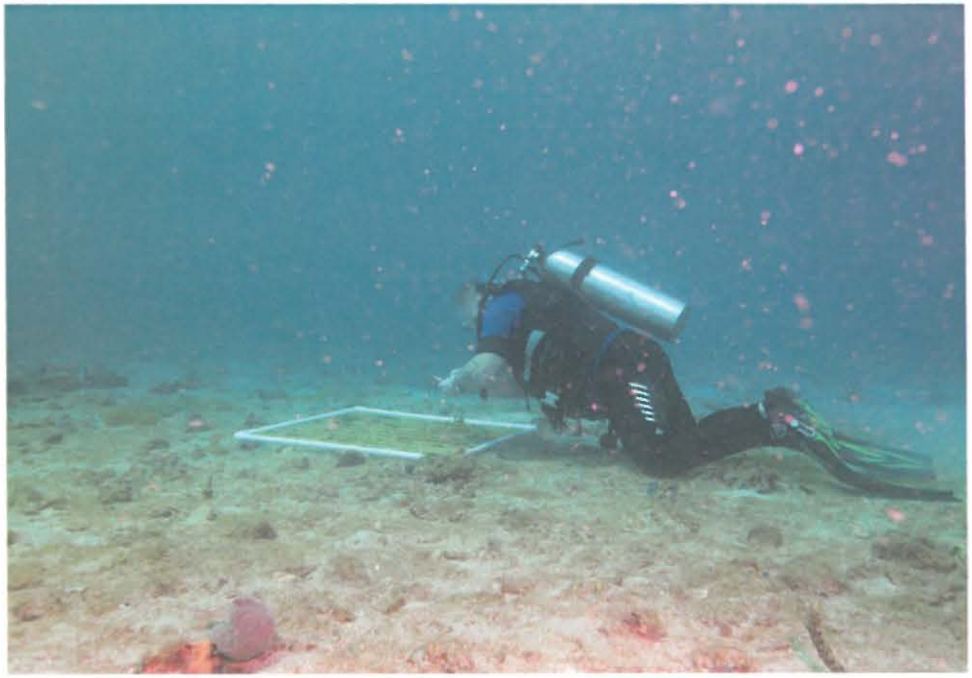
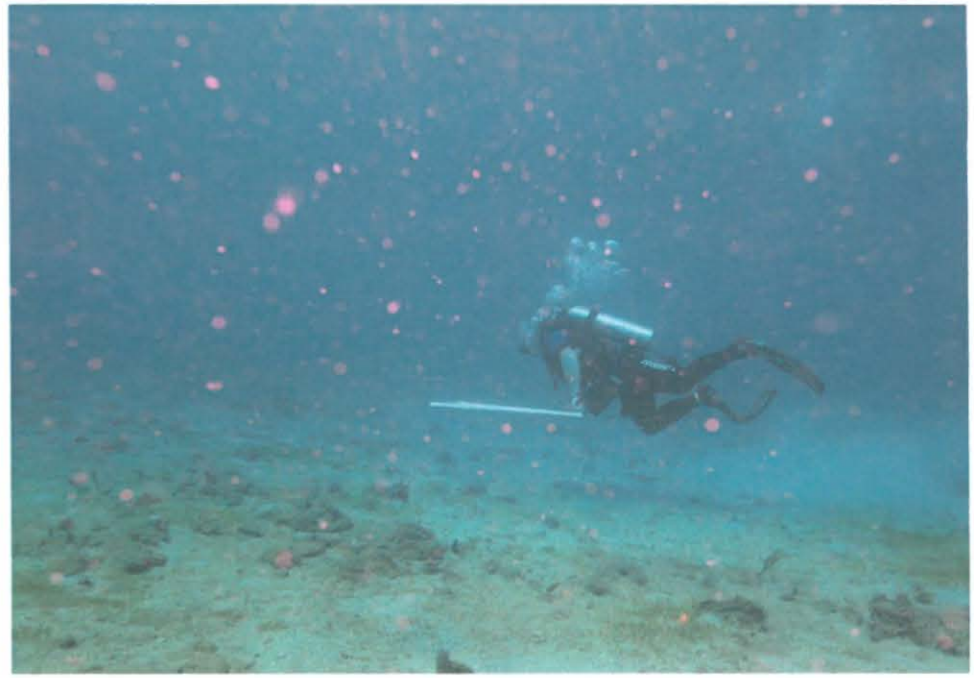





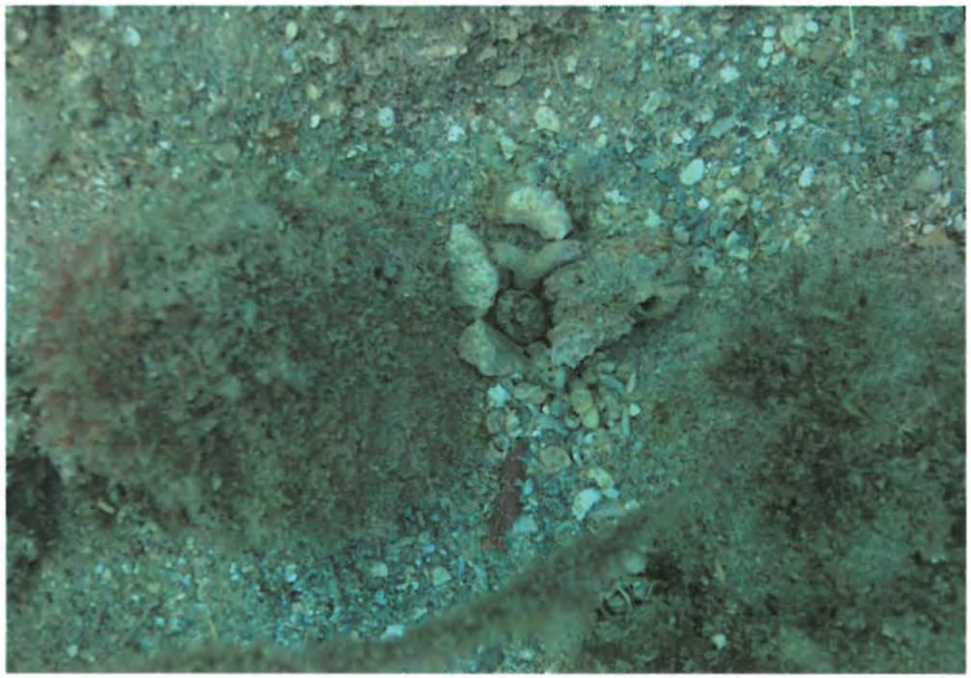






APPENDIX B

Data Sheets

Seagrass Data Sheet Job# 1262 | Compass heading: | Tide Start: | Tide End:

Date 8/28/13 | Site (Transect #) BB 1 | Crew: | Weather: fair seas clear water

Species: (HW) Halodule wrightii, (R) Ruppia, (TT) Thalassia, (S) Syrigodium, (HD) Halophila decipiens, (AA) attached algae, (DA) drift algae

Abundance: r = solitary, + = few, 1 = < 5% cover, 2 = 5-25% cover, 3 = 26-50% cover, 4 = 51-75% cover, 5 = 76-100% cover

Epiphyte density: 1=clean, 2=light, 3=moderate, 4=heavy

Site Comments:

Sediments: 1=shelly sand, 2=sand, 3=muddy sand, 4=muck

Line Intercept:

Station (m)	Time	Depth (cm)	Species	Abundance	Quads Occupied	Blade Length (5)	Epiphyte Density	Epiphyte desc.	Sediment	Station Comments
1		45	Hd	1	28	2-3cm			Sand w/ rubble	
2		43	"	3	84	"			Sand	
3		44	"	3	82	"			"	
4		44	"	1	10	"			Sand + Rubble	
5		44	"	2	70	"			"	
6		44	"	2	43	"			"	Freq: $\frac{662}{1500} = 0.44$
7		44	"	3	85	"			"	
8		43	"	2	60	"			"	
9		43	"	1	12	"			"	abund: $\frac{28}{15} = 1.86$
10		43	"	r	7	"			"	
11		43	"	1	23	"			"	
12		43	"	3	79	"			"	density: $\frac{28}{15} = 1.86$
13		44	"	2	22	"			"	
14		44	"	1	6	"			"	
15		43	"	2	31	"			"	
				28	662					
				15	44					
			abundance							
			1.86		0.44 = 44% cover					

Dial Cordy and Associates, Inc. (904) 241-8821
490 Osceola Avenue Jacksonville Beach, FL 32250

Seagrass Data Sheet	Job# 1262	Compass heading:	Tide Start:	Tide End:
Date 8/30/13	Site (Transect #) BB 2	Crew:		Weather: excellent seas & skies

Species: (HW) Halodule wrightii, (R) Ruppia, (TT) Thalassia, (S) Syrigodium, (HD) Halophila decipiens, (AA) attached algae, (DA) drift algae

Abundance: r = solitary, + = few, 1 = < 5% cover, 2 = 5-25% cover, 3 = 26-50% cover, 4 = 51-75% cover, 5 = 76-100% cover

Epiphyte density: 1=clean, 2=light, 3=moderate, 4=heavy

Sediments: 1=shelly sand, 2=sand, 3=muddy sand, 4=muck

Site Comments:

Line Intercept: |---|

Station (m)	Time	Depth (cm)	Species	Abundance	Quads Occupied	Blade Length (5)	Epiphyte Density	Epiphyte desc.	Sediment	Station Comments
1		45	Hd	1	11	2 cm	0		Sand w/ rubble	
2		45	"	3	78	"			"	
3		46	"	1	16	"			"	
4		46	"	1	6	"			"	
5		46	"	1	12	"			"	$F = \frac{408}{1300} = 0.31$
6		46	"	4	83	"			"	
7		45	"	2	42	"			"	
8		45	"	3	83	"			"	$A = \frac{22}{13} = 1.69$
9		45	"	2	28	"			"	
10		45	"	1	13	"			"	
11		45	"	1	15	"			"	$D = \frac{22}{13} = 1.69$
12		45	"	1	8	"			"	
13		44	"	1	13	"			1	
				22	408					

1.69 = abundance

$\frac{408}{1300}$ = 0.31 or 31% cover

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